elektor

up-to-date electronics for lab and leisure

D 71683

91

November 1982

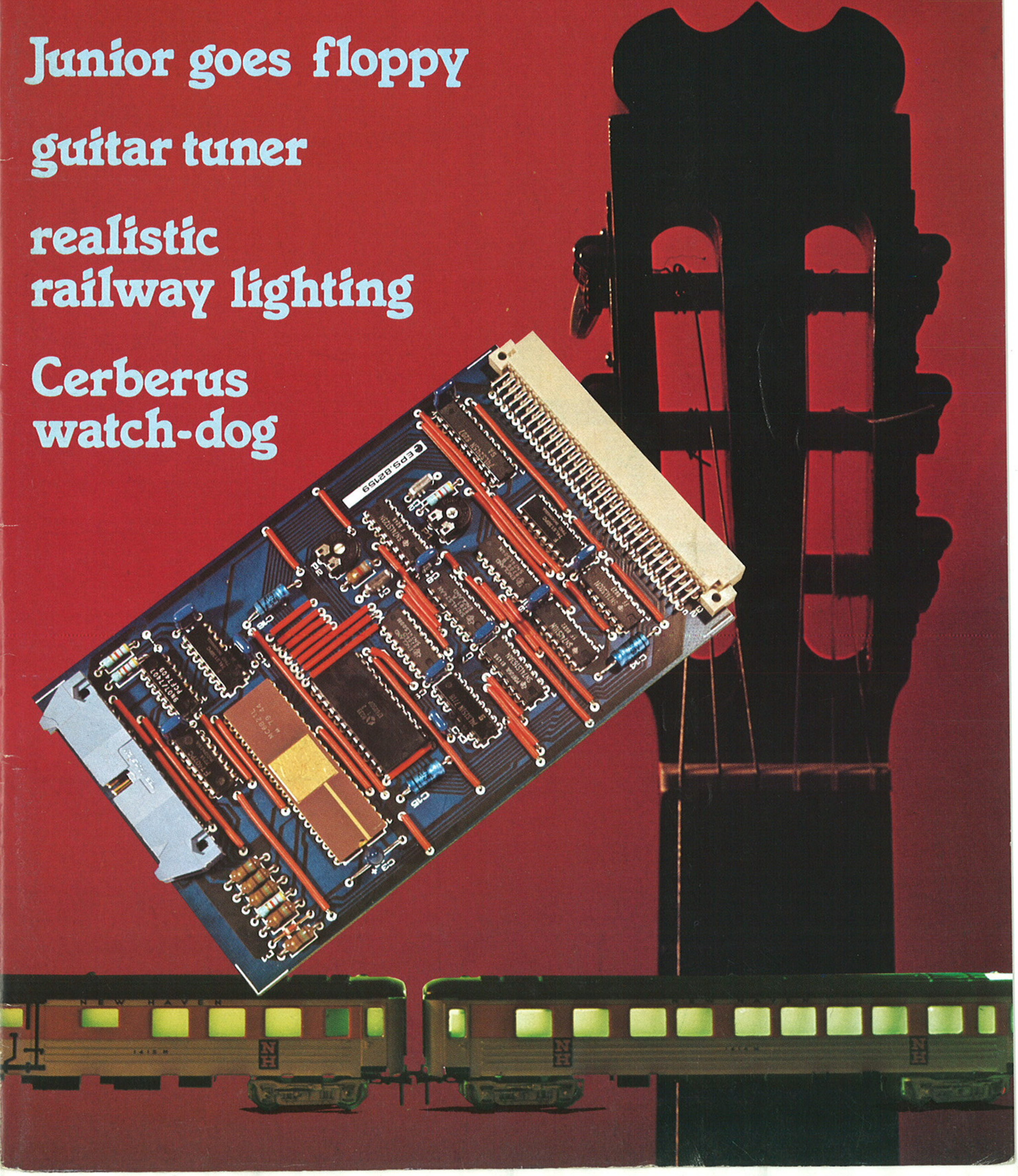
75p.
IR 112 p. (incl. VAT)
$ 2.50

Junior goes floppy

guitar tuner

realistic railway lighting

Cerberus watch-dog



TTLs

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
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7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
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7460	15p
7470	30p
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7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
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74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
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74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
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74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

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74LS11	13p
74LS12	13p
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74LS14	25p
74LS15	12p
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74LS93	22p
74LS96	50p
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74LS112	20p
74LS113	20p
74LS114	22p
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74LS123	34p
74LS124	90p
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74LS126A	25p
74LS132	34p
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74LS161A	36p
74LS162A	36p
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74LS165A	50p
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74LS540	90p
74LS541	80p
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
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40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
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4515	110p
4516	55p
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4528	50p
4531	125p
4532	70p
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4536	270p
4538	90p
4539	70p
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4543	75p
4553	245p
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4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	400p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	700p

TTL & ECL

10116	70p
10231	350p

LINEAR I.Cs

AY1-0212	600p	MC3403	65p
AY1-5050	99p	MK50398	750p
AY3-8910	380p	ML920	800p
AY3-8912	625p	MM57160	620p
AY5-4007D	520p	NE531	140p
CA3019	80p	NE555	16p
CA3046	70p	NE556	45p
CA3080E	70p	NE564	420p
CA3086	48p	NE565	120p
CA3089E	200p	NE566	155p
CA3090AQ	375p	NE567	140p
CA3130E	90p	NE571	400p
CA3140E	40p	NE5534A	250p
CA3160E	100p	RC4136	60p
CA3161E	150p	RC4151	200p
CA3162E	450p	S566B	225p
CA3189E	300p	SAA1900	£16
DAC1408-8	200p	SAD1024A	850p
HA1388	250p	SFF96364	800p
ICL7106	700p	SL490	350p
ICL8038	300p	SN76477	450p
LF351	48p	SP8515	750p
LF356P	95p	TA7205	90p
LM10C	325p	TAA550	50p
LM301A	25p	TAA621	275p
LM310	120p	TBA641B	300p
LM311	70p	TBA651	200p
LM318	150p	TBA800	80p
LM319	215p	TBA810	100p
LM324	30p	TBA820	80p
LM339	50p	TBA950	225p
LM348	65p	TC9109	750p
LM358P	60p	TCA210	350p
LM377	175p	TCA220	350p
LM380	75p	TCA940	175p
LM381AN	180p	TDA1004A	300p
LM386	90p	TDA1008	320p
LM387	120p	TDA1010	200p
LM389	95p	TDA1022	500p
LM393	100p	TDA1024	120p
LM394CH	300p	TDA1034B	250p
LM709	36p	TDA1170	300p
LM710	50p	TDA2002V	325p
LM711	70p	TDA2020	320p
LM733	60p	TLO71/81	25p
LM741	18p	TLO72/82	45p
LM747	70p	TLO74	100p
LM748	35p	TLO83	75p
LM1886	700p	TLO84	90p
LM1889	350p	TLO94	200p
LM2917	200p	TL170	50p
LM3900	50p	UAA170	170p
LM3909	85p	ULN2003	108p
LM3911	125p	XR2206	300p
LM3914	200p	ZN414	80p
LM3915	200p	ZN419C	190p
LM3916	225p	ZN424E	130p
LM13600	110p	ZN425E	340p
MB3712	200p	ZN426E	300p
MC1310P	150p	ZN427E	590p
MC1458	36p	ZN428E	400p
MC1495L	350p	ZN1034E	200p
MC1496	70p	ZN1040E	670p
MC3340P	120p	ZNA234	850p
MC3401	50p		

CPU's

1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£12

SUPPORT DEVICES

3242	800p
6522	310p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	220p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	300p
2112	300p
2114L	90p
2114L-2	95p
4027	300p
4116L-2	90p
4118	400p
4164	550p
4816AP-3	280p
5101L	300p
6116P-3	420p
6116LP-3	550p
6514	250p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	700p
MC14411	675p

EPROMS

2516	250p
2708	250p
2716	250p
2532	400p
2732	450p
2716 300nS	500p
2732 300nS	750p

UARTS

AY-5-1013P	300p
AY-5-1015P	300p
IM6402	450p
TR1602	300p
COM 8017	300p

CHARACTER GEN.

RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRT CONTROLLER

CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
9365	£48
EF9366	£48
TMS9927	£18

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	420p

CRYSTALS

100KHz	250p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
18MHz	200p
26.690MHz	150p
27.145MHz	200p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

AD558	775p
AD561J	£20
DM8131	275p
DP8304	250p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24" Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24" Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24" Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24" Cable with 25 way D Connector
Male 500p Female 540p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn.	200p	250p	320p	380p	560p

EURO CONNECTORS

		Plug	Socket
DIN 41612	2 · 32-way	300p	350p
angled	2 · 32-way	350p	400p
angled	3 · 32-way	400p	—

(for 2 · 32 way specify a - b or a - c)

DIN 41617	31-way	200p	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/side entry)	100p	100p	100p	150p

25 way Centronix Type Conn. £6.50
37 way Centronix Type conn. £6.50

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p

100mA +ve			TO-92	
5v	78L05	30p	79L05	50p
12v	78L12	30p	79L12	50p
15v	78L15	50p	79L15	50p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MSC2400	190p	TIL116	70p

LEDS

0.125"		0.2"	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	**DRIVERS**	
FND507	90p	9368	250p
MAN3640	175p	9370	300p
MAN4640	200p	UDN6118	320p
MAN6610	200p	UDN6184	320p

★ SPECIAL OFFER ★

	1-24	25-99
4116-3	100p	95p
2716	250p	225p
2532	375p	360p

TRANSISTORS

BC107/8	11p
BC109/C	16p
BC140	30p
BC141	30p
BC160	30p
BC161	30p
BC177	18p
BC178/9	20p
BC182/L	10p
BC183/L	10p
BC184/L	10p
BC212/L	10p
BC213/L	10p
BC214/L	10p
BC327	16p
BC337	10p
BC338	15p
BC477	30p
BC516/7	36p
BC547B	12p
BC548B	12p
BC549C	12p
BC557B	12p

BC558B	12p	MJE2955	130p	2N2219A	30p
BC559C	16p	MJE3055	70p	2N2222A	30p
BCY70	20p	MPF102	30p	2N2646	45p
BCY71/2	20p	MPF103/4	30p	2N2905A	30p
BD131	60p	MPF105	30p	2N3053	30p
BD132	40p	MPSA12	30p	2N3054	65p
BD135	40p	TIP29A/B	35p	2N3055	50p
BD136	35p	TIP29C	40p	2N3442	140p
BD139	40p	TIP30A/C	35p	2N3702/3	12p
BD241B	75p	TIP31B	40p	2N3704/5	12p
BD242B	75p	TIP31C	50p	2N3773	300p
BF244B	25p	TIP32A/C	75p	2N3819	22p
BF256B	45p	TIP35C	150p	2N3820	40p
BF257/8	30p	TIP36C	160p	2N3866	100p
BF259	35p	TIP41A	45p	2N3904/6	18p
BF337	30p	TIP41B	50p	2N4871	60p
BFR96	180p	TIP41C	55p	2N5245	40p
BFT66	200p	TIP42A	50p	2N5457/8	40p
BFY50/51	24p	TIP42B	45p	2N5459	40p
BFY52	24p	TIP42C	60p	2N6027	48p
BFY90	75p	TIP2955	60p	3N128	120p
MJ2501	225p	TIP3055	60p	3N140/1	120p
MJ2955	90p	2N918	35p	40673	75p
MJ3001	225p	2N2160	295p	40871/2	100p

DIODES

BY127	12p
OA47	9p
OA91	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	6p
IN4006/7	7p
IN5401/3	14p
IN5404/7	19p
IS920	9p

BRIDGES

1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
10A100V	180p

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V	
400MW	9p
1W	15p

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6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
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contents

selektor 11-18

drum interface 11-20
G. Lausberg

The synthesizer is probably the best source of 'electronic sounds' in contempory music and it is usually played with the traditional keyboard. However, almost any instrument can be used to play a synthesizer, including a drum, as this article shows.

talking dice 11-24

Once upon a time, dice were just dice. They rolled and had spots. Then along came electronic dice, no rolling, no spots, just LEDs! Now we have the ultimate — talking dice. It does everything except laugh when you lose . . . and even that can be arranged!

model train lighting 11-28

Lighting in the carriages of model trains is very desirable and realistic — until the train stops! The two-rail constant lighting control in this article will be well received by the mini-travellers.

guitar tuner 11-33

Many guitarists have realised that by far the best way to tune a guitar is by means of a visual electronic tuning aid. The tuning aid in this article is electronic but, more important, it is very accurate.

cerberus 11-38

Sophisticated alarm systems tend to be expensive. What the average householder needs is a simple, good quality, low cost system which detects entry and then scares the living daylights out of the intruder!

floppy disk interface for the junior 11-42
G. de Cuyper

The hardware for this floppy disk interface has been designed to be universal. The owners of a KIM, SYM, AIM-65, ACORN, as well as the Junior and other computers can use this low-cost interface to extend their computer to a real personal computer. An interface for connecting the EPSON printer is also provided.

cubular bell 11-54
K. Siol

Cubes are attractive to the human mind, a fact well proved by Rubik. Take a cube, add sound and it becomes quite fascinating. Once picked up it becomes difficult to put down.

mini-organ extension 11-56

Those of you who built the mini-organ last year will welcome this extension circuit. It brings the mini-organ half-way to being a synthesizer.

kitchen timer 11-58

A versatile timer with the facility of four separate preset time periods available at the touch of a button.

market 11-59

switchboard 11-61

advertisers index 11-74

A lab power supply is only one of the projects that will arrive with the December issue. A look at digital filters and the world of robotics will also appear together with the software for the floppy disk interface. And then there is . . . but we keep that a secret until next month.

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160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1uF **42p**; 1u5 **45p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

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39n, 56n	12p
82n, 100n	11p
100V	
100n, 120n	10p
150n, 180n	12p
220n, 270n	15p
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1N4004/5	6
1N4006/7	7
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1N5404	16
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12A 400V	82
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75451/2	52
75454	85
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747C 14 pin	65
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AY-5-4007D	520
AY-5-8100	775
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CA3012	175
CA3014	275
CA3018	86
CA3019	30
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
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HA1388	255
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LF351	48
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LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM301	24
LM307	45
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	180
LM3915	220
LM3916	220
LM13600	110
LS7220	280
M252AA	625
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
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NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5534A	150
OM335	785
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TBA990Q	350
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TCA270Q	350
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TDA1024	420
TDA1034	350
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TDA2030	295
TDB0701	420
TL170	50
TL061CP	40
TL062CP	60
TLO64CN	98
TLO71CP	24
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2240	120
XR2266	360
ZN414	80
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

TRANSISTORS

AC125	35
AC126/7	35
AC128	30
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
ACY39/41	85
AD142	120
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF117/8	90
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC119	38
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY30	68
BCY34	85
BCY35	50
BCY39/40	85
BCY41/42	14
BCY45	50
BCY58/59	35
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD121	95
BD124	115
BD131/32	48
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	99
BD696A	99
BDY56	180
BDY60	160
BF115	35
BF154/8	25
BF167	29
BF173	27
BF177	25
BF178	30
BF179	35
BF180/2	38
BF184/5	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	300
BF224A	25
BF224B	29
BF245	30
BF256A	35
BF256B	45
BF257/8	32
BF259	35
BF274	42
BF336/7	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY18	50
BFY50/51	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSC20	20
BSX26/29	34
BSX78	45
BSY26	30
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ490	90
MJ491	175
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE521	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	25
MPSA08	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU56	60
MPSU56	60
MPU131	52
OC26	170
OC28/35	220
OC36/41	75
OC42/44	75
OC45/70	40
OC71/72	40
OC74/75	50
OC76/77	50
OC81/82	50
OC83/84	40
OC170/71	50
OC200	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	39
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS46	45
TIS48	50
TIS59/74	50
TIS88A	50
TIS90/91	30
UC734	65
VK101	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1302	45
2N1303	65
2N1304/5	60
2N1306/7	65
2N1308	68
2N1613	30
2N1670	150
2N1671B	160
2N2160	295
2N2217	45
2N2218A	25
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	25
2N2297	25
2N2303	45
2N2368	25
2N2369A	18
2N2476	50
2N2483/4	27
2N2646	45
2N2846	80
2N2904/5	28
2N2906/7	26
2N2907A	26
2N2926G	10
2N3011	28
2N3053	26
2N3054	58
2N3055	48
2N3108	45
2N3252	46
2N3302	30
2N3441/2	140
2N3614/5	199
2N3663	15
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3824	65
2N3866	90
2N3870	150
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4041	40
2N4058	10
2N4061/2	10
2N4064	115
2N4069	45
2N4220	78
2N4234/6	48
2N4264	24
2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4859	78
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	70
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1679	190
2SC1923	50
2SC1945	225
2SC1963	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2314	85
2SC2166	165
2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40250	95
40311	60
40313	130
40315	90
40316	95
40317/20	80
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40636	175
40673	85
40871/2	90

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	24
7426	28
7427	22
7428	26
7430	14
7432	22
7433	22
7437	25
7438	25
7440	15
7441	68
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	40
7476	30
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	205
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	40
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	60
74119	80
74120	60
74121	25
74122	40
74123	40
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	90
74148	70
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	48
74163	48
74164	48
74165	48
74166	48
74167	150
74170	125
74172	275
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	45
74195	46
74196	46
74197	46
74198	84
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	199
74285	199
74290	105
74293	125
74297	236
74298	100
74351	195
74365	55
74366	55
74367	55
74368	55
74390	99
74393	99
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74L

74L00	68
74L04	85
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S

74S00	38
S02	00
S03	00
S04	40
S05	00
S08	00
S20	00
S32	70
S74	00
S86	00
S112	00
S114	00
S132	110
S133	00
S138	180
S157	00
S158	210
S188	00
S189	158
S194	320
S195	795
S201	320
S225	510
S241	390
S251	70
S257	00
S262	850
S287	300
S288	210
S289	195
S301	00
S412	00
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	13
LS13	20
LS14	34
LS15	13
LS20	13
LS21	13
LS22	13
LS26	14
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	52
LS86	16
LS90	28
LS91	60
LS92	32
LS93	26
LS95	40
LS96	95
LS107	40
LS109	28
LS112	26
LS113	22
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	40
LS133	30
LS136	24
LS138	32
LS139	32
LS145	70
LS147	150
LS148	73
LS151	40
LS153	40
LS155	35
LS156	36
LS157	26
LS158	30
LS160	35
LS161	35
LS162	35
LS163	35
LS164	40
LS165	55
LS166	65
LS168	84
LS170	75
LS173	65
LS174	50
LS175	45
LS181	95
LS183	180
LS190	45
LS191	45
LS192	45
LS193	45
LS194	35
LS195	35
LS196	45
LS197	60
LS200	275
LS202	275
LS221	55
LS240	65
LS241	65
LS242	65
LS243	65
LS244	60
LS245	70
LS247	50
LS248	55
LS249	55
LS251	30
LS253	35
LS257	35
LS258	35
LS259	58
LS260	22
LS261	138
LS266	20
LS273	60
LS275	225
LS279	30
LS280	130
LS283	40
LS290	45
LS293	40
LS295	86
LS298	85
LS299	190
LS300	175
LS302	175
LS320	270
LS323	195
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	125
LS352	88
LS353	88
LS362	750
LS363	150
LS364	150
LS365	30
LS366	30
LS367	30
LS368	40
LS373	65
LS374	65
LS375	43
LS377	70
LS378	60
LS379	65
LS384	395
LS385	250
LS390	50
LS393	45
LS395	125
LS399	175
LS445	100
LS471	620
LS490	200
LS541	120
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	150
LS673	550

SWITCHES

TOGGLE: 2A, 250V

SPST	**33p**
DPDT	**44p**

SUB-MIN TOGGLE

SPST on/off	**54p**
SPDT c/over	**60p**
SPDT centre off	**85p**
SPDT biased both ways	**105p**
DPDT 6 tags	**75p**
DPDT centre off	**88p**
DPDT biased both ways	**145p**
DPDT 3 positions on/on/on	**185p**
3-pole 2 way	**205p**

SLIDE 250V:

DPDT 1A	**14p**
DPDT 1A c/off	**15p**
DPDT ½A	**13p**

PUSHBUTTON 6A
with 10mm Button

SPDT latching	**99p**
DPDT latching	**145p**
SPDT moment	**99p**
DPDT moment	**145p**

Mini Non Locking

Push to Make	**15p**
Push to Break	**25p**

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**. (SPDT) 4 way **190p**.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way - DP switch)
Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	**28p**
ROCKER: 10A/250V SPDT	**38p**
ROCKER: 10A/250V DPDT c/off	**95p**
ROCKER: 10A/250V DPST with neon	**85p**

THUMBWHEEL Mini front mounting

Decade Switch Module	**220p**
B.C.D. Switch Module	**275p**
Mounting Cheeks (per pair)	**75p**

VEROBOARD 0.1in

	clad	plain
2½ · 3¼	**80p**	
2½ · 5	**91p**	—
3¾ · 3¾	**91p**	—
3¾ · 5	**105p**	**87p**
3¾ · 17	**360p**	**232p**
4¾ · 17	**470p**	—
Pkt of 100 pins		**50p**
Spot face cutter		**135p**
Pin insertion tool		**178p**

VQ Board	**180**
DIP Board	**350**
Vero Strip	**374**

PROTO DECs

Veroblock	**405p**
S-Dec	**350p**
Eurobreadboard	**520p**
Bimboard 1	**575p**
Superstrip SS2	**1350p**

VERO WIRING PEN + Spool **340p**
Spare Spool **75p**
Combs **6p**

DALO ETCH RESIST PEN
+ Spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz **325 pr**

COPPER CLAD BOARDS

Fibre glass	Single sided	Double sided	SRBP 9.5 · 8.5
6 · 6	**90p**	**110p**	**95p**
6 · 12	**150p**	**195p**	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	**8p**	**25p**
14pin	**10p**	**35p**
16pin	**10p**	**42p**
18pin	**16p**	**52p**
20pin	**22p**	**60p**
22pin	**25p**	**70p**
24pin	**25p**	**70p**
28pin	**28p**	**80p**
40pin	**30p**	**99p**

EDGE CONNECTORS

	1	156
2 · 15 way		**140p**
2 · 18 way	**180p**	**145p**
2 · 22 way	**199p**	**200p**
2 · 23 way	**210p**	—
2 · 25 way	**225p**	**220p**
2 · 28 way	**210p**	—
2 · 30 way	**245p**	—
2 · 36 way	**295p**	—
2 · 40 way	**315p**	—
2 · 43 way	**395p**	—
2 · 75 way	**550p**	—

IDC CONNECTORS

Female Header Socket	PCB Plugs with latch Pins Strt	pins Angle	Header Socket	PCB Pins Angled
2 × 5 way	**90p**	**99p**	**85p**	**65p**
2 × 8 way	**130p**	**150p**	**110p**	**78p**
2 × 10 way	**145p**	**166p**	**125p**	**90p**
2 × 13 way	**175p**	**200p**	**150p**	**110p**
2 × 17 way	**205p**	**236p**	**169p**	**135p**
2 × 20 way	**220p**	**250p**	**190p**	**150p**
2 × 25 way	**235p**	**270p**	**200p**	**175p**
2 × 30 way	—	—	**230p**	**220p**

EURO CONNECTORS

	Female Socket Strt Pins	Female Socket Angle Pins	Male Plug Strt Pins	Male Plug Angle Pins
DIN41617 31way	**170p**	–	–	**175p**
DIN41612 2 · 32 A · B	**285p**	**325p**	**220p**	**295p**
DIN41612 2 · 32 A · C	**300p**	**340p**	**240p**	**300p**
DIN41612 3 · 32 A · B · C	**360p**	**385p**	**260p**	**400p**

PANEL METERS

FSD
60 × 46 × 35mm

- 0-50μA
- 0-100μA
- 0-500μA
- 0-1mA
- 0-5mA
- 0-10mA
- 0-50mA
- 0-100mA
- 0-500mA
- 0-1A
- 0-2A
- 0-25V
- 0-50V AC
- 0-300V AC
- "S"
- "VU"

495p each

RELAYS

Miniature, enclosed, PCB mount. Our RL6 series

S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W **210p**

D.P.C.O.
43Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W **218p**
RL6-111 170Ω coil, 8V-14V; 250V AC 5A **220p**
RL6-114 740Ω coil, 17V5-29V 250V 5A AC **222p**

AMPHENOL PLUGS

IEEE 24 Way	**578**
Centronics Parallel 36 Way	**556**

BUZZERS, miniature solid-state 6V; 9V & 12V **70p**

LOUDSPEAKERS

Miniature, 0.3W 8Ω

2in, 3½in, 2½in, 3in	**80p**
2½in 40Ω, 64Ω or 80Ω	**80p**

ASTEC UHF MODULATORS

Standard 6MHz	**280p**
Wideband 8MHz	**425p**

'WEMON' New Version
WATFORD'S
Ultimate Monitor IC

A 4K Monitor chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr A. A. Berk in Practical Electronics, June 1981.

Only £10 + 50p P&P

CRYSTALS

32.768KHz	**100**
100KHz	**235**
200KHz	**268**
455KH	**370**
1MHz	**275**
1.008M	**275**
1.28MHz	**392**
1.6MHz	**395**
1.8NHz	**395**
1.8432M	**200**
2.0MHz	**225**
2.4576M	**200**
3.278M	**150**
3.5794M	**98**
3.6864M	**300**
4.0MHz	**150**
4.032MHz	**290**
4.80MHz	**200**
4.194304M	**200**
4.433619M	**100**
5.0MHz	**160**
5.185MHz	**300**
5.24288M	**390**
6.0MHz	**140**
6.144MHz	**150**
6.5536MHz	**225**
7.0MHz	**150**
7.168MHz	**250**
7.68MHz	**200**
8.0MHz	**150**
8.08333M	**395**
8.86723M	**175**
9.00MHz	**150**
10.0MHz	**175**
10.24MHz	**200**
10.7	**150**
12.0NHz	**175**
12.528M	**300**
14.31814M	**170**
16.0MHz	**200**
18.0MHz	**180**
18.432M	**150**
20.0MHz	**200**
19.968MHz	**150**
24.0MHz	**170**
07124.930M	**325**
26.69M	**150**
27.648M	**170**
27.145M	**190**
38.66667M	**175**
48.0MHz	**170**
100.0MHz	**295**
116.0MHz	**250**

ETI PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	**145p**	**165p**	**240p**	**380p**
Double ended DIP (Header Plug) Jumper				
6 inches	**185p**	**205p**	**300p**	**465p**
12 inches	**198p**	**215p**	**315p**	**490p**
24 inches	**210p**	**235p**	**345p**	**540p**
36 inches	**230p**	**250p**	**375p**	**595p**

IDC Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	**160p**	**200p**	**260p**	**300p**
Double ended	**290p**	**370p**	**480p**	**525p**

ANTEX SOLDERING IRON

C 15W	**450p**	CX17W	**475p**
CCN 15W	**495p**	CX25W	**500p**
Spare tips, assorted sizes			**65p**
Spare Elements			**210p**
Iron stand with sponge			**165p**

Soldercon Pins
100 pins **70p**
500 pins **325p**

DIL PLUG (Headers)

	Solder	IDC
14 pin	**44p**	**99p**
16 pin	**49p**	**105p**
24 pin	**88p**	**178p**
40 pin	**250p**	**255p**

RIBBON CABLE
price per foot

	Grey	Color
10 way	**12p**	**22p**
16 way	**18p**	**32p**
20 way	**25p**	**40p**
24 way	**35p**	**50p**
34 way	**48p**	**60p**
40 way	**55p**	**75p**
50 way	**65p**	**90p**
64 way	**85p**	**110p**

ZIF DIL SOCKETS

24 pin	**575p**
28 pin	**820**
40 pin	**975p**

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	**80p**	**110p**	**160p**	**250p**
Angle Pins	**160p**	**210p**	**250p**	**355p**
W/Wrap Pins	**120p**	**130p**	**195p**	**295p**
Sockets				
Solder lugs	**110p**	**160p**	**210p**	**350p**
Angled Pins	**165p**	**215p**	**290p**	**440p**
W/Wrap Pins	**150p**	**180p**	**240p**	**420p**
Covers	**95p**	**95p**	**95p**	**110p**

25 way 'D' CONNECTOR
Jumper Lead Cable Assembly

18" long, Single end, Male	**560p**
18" long, Single end, Female	**570p**
36" long, Double Ended, M M	**1025p**
36" long, Double Ended, F F	**1050p**
36" long, Double Ended, M F	**995p**

PIEZO TRANSDUCERS
Type PB-2720 **55p**

TRANSFORMERS: Prim. 240V
3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V 100mA **98**

pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **200p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **270p**

Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **220p**
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **330p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **465p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

	· ve		ve	
1A	T03	Metal case		
5V	7805	**145p**	7905	**220p**
12V	7812	**145p**	7912	**220p**
15V	7815	**145p**	7915	**220p**
18V	7818	**145p**		
1A	TO220	Plastic		
5V	7805	**40p**	7905	**45p**
12V	7812	**40p**	7908	**60p**
15V	7815	**40p**	7912	**45p**
18V	7818	**40p**	7915	**45p**
24V	7824	**40p**	7918	**45p**
			7924	**60p**
100mA	TO92 casing	Plastic		
5V	78L05	**30p**	79L05	**60p**
6V	78L62	**30p**		—
8V	78L82	**30p**		—
12V	78L12	**30p**	79L12	**60p**
15V	78L15	**30p**	79L15	**60p**

CA3085	**95p**
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4006	**50**
4007	**15**
4008	**48**
4009	**24**
4010	**24**
4011	**11**
4012	**16**
4013	**25**
4014	**50**
4015	**50**
4016	**20**
4017	**38**
4018	**45**
4019	**25**
4020	**50**
4021	**50**
4022	**50**
4023	**16**
4024	**32**
4025	**16**
4026	**80**
4027	**24**
4028	**50**
4029	**60**
4030	**30**
4031	**125**
4032	**80**
4033	**125**
4034	**140**
4035	**65**
4036	**275**
4037	**110**
4038	**110**
4039	**290**
4040	**50**
4041	**60**
4042	**45**
4043	**50**
4044	**50**
4045	**105**
4046	**65**
4047	**50**
4048	**40**
4049	**25**
4050	**25**
4051	**45**
4052	**60**
4053	**50**
4054	**85**
4055	**85**
4056	**85**
4057	**1915**
4059	**480**
4060	**60**
4061	**2295**
4062	**995**
4063	**85**
4066	**30**
4067	**245**
4068	**16**
4069	**16**
4070	**15**
4071	**15**
4072	**15**
4073	**15**
4075	**15**
4076	**46**
4077	**18**
4078	**18**
4081	**16**
4082	**16**
4085	**50**
4086	**52**
4909	**125**
4093	**26**
4094	**120**
4095	**75**
4096	**70**
4097	**290**
4098	**75**
4099	**110**
4160	**95**
4161	**99**
4162	**99**
4163	**99**
4174	**99**
4175	**105**
4194	**105**
4406	**790**
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4410	**725**
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4433	**770**
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4450	**350**
4451	**350**
4490	**350**
4500	**675**
4501	**28**
4502	**60**
4503	**40**
4504	**75**
4506	**35**
4507	**35**
4508	**130**
4510	**46**
4511	**45**
4512	**50**
4513	**199**
4514	**115**
4515	**115**
4516	**55**
4517	**275**
4518	**40**
4519	**30**
4520	**50**
4521	**110**
4522	**125**
4526	**70**
4527	**65**
4528	**70**
4529	**150**
4530	**90**
4531	**130**
4532	**70**
4534	**455**
4536	**275**
4538	**90**
4539	**110**
4541	**140**
4543	**80**
4544	**150**
4549	**375**
4553	**245**
4554	**190**
4555	**35**
4556	**35**
4557	**320**
4558	**120**
4560	**160**
4561	**104**
4562	**495**
4566	**165**
4568	**250**
4569	**175**
4572	**30**
4580	**460**
4581	**250**
4582	**99**
4583	**99**
4584	**48**
4585	**99**
4597	**330**
4598	**290**
4599	**290**
40085	**90**
40097	**45**
40098	**193**
40100	**215**
40101	**130**
40102	**140**
40103	**175**
40104	**95**
40105	**110**
40106	**46**
40107	**60**
40108	**450**
40109	**100**
40110	**300**
40114	**240**
40161	**194**
40163	**65**
40174	**65**
40175	**75**
40181	**220**
40182	**90**
40192	**90**
40193	**68**
40194	**90**
40195	**72**
40244	**195**
40245	**195**
40257	**195**
40373	**240**
40374	**245**

OPTO

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Volume 8 — Number 11 **ISSN 0308-308X**

Elektor Publishers Ltd., Elektor House,
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Tel.: Canterbury (0227) 54430. Telex: 965504.
Office hours: 8.30 - 12.30 and 13.30 - 16.30.

Bank: 1. Midland Bank Ltd., Canterbury, A/C no. 11014587
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3. Canada only: The Royal Bank of Canada,
c/o Lockbox 1969, Postal Station A, Toronto,
Ontario, M5W 1W9. A/C no. 160-279-7.
Please make all cheques payable to Elektor Publishers Ltd. at the above address.

Elektor is published monthly. July/August is a double issue.

SUBSCRIPTIONS: Elektor Publishers Ltd., Elektor House,
10 Longport, Canterbury CT1 1PE, Kent, U.K.
Subscriptions January to December incl.:

U.K.	U.S.A./Can.		other countries	
	surface mail	airmail	surface mail	airmail
£ 6.50	$ 21.00	$ 39.00	£ 8.50	£ 17.50

Subscriptions normally run to December incl.

Back issues are available at original cover price.

Change of address: Please allow at least six weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.

PUBLISHING MANAGER: A.J. Brialey
ASSISTANT PUBLISHING MANAGER: Mrs. S. Barber
ADVERTISING MANAGER: S. Brooks
National advertising rates for the English-language edition of Elektor and international rates for advertising in the Dutch, French and German issues are available on request.

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ADM = Administration
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Dutch edition: Elektuur B.V., 6190 AB Beek (L), the Netherlands.
German edition: Elektor Verlag GmbH, 5133 Gangelt, W-Germany.
French edition: Elektor Sarl, Le Seau, 59270 Bailleul, France.
Italian edition: Elektor, 20092 Cinisello B., Italy.
Spanish edition: Elektor, Villanueva, 19, 1.°, Madrid-1.
Greek edition: Elektor, Karaiskaki 14, Voula, Athens.

Distribution in U.K.:
Seymour Press Ltd., 334 Brixton Road, London SW9 7AG.

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Printed in the Netherlands.

decoder

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA741, LM741, MC1741, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

$U_{CEO, max}$	20 V
$I_{C, max}$	100 mA
$h_{fe, min}$	100
$P_{tot, max}$	100 mW
$f_{T, min}$	100 MHz

Some **'TUN's** are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP's** are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
$U_{R, max}$	25 V	20 V
$I_{F, max}$	100 mA	35 mA
$I_{R, max}$	1 μA	100 μA
$P_{tot, max}$	250 mW	250 mW
$C_{D, max}$	5 pF	10 pF

Some **'DUS'** are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG's** are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:
p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}
A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF, or 0.000 000 000 004 7 F . . .
Capacitance value 10n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbon types, unless otherwise specified.
The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are measured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: U_b = 10 V, not V_b = 10 V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers
- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service list' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Mondays from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements on or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

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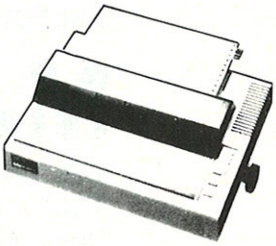

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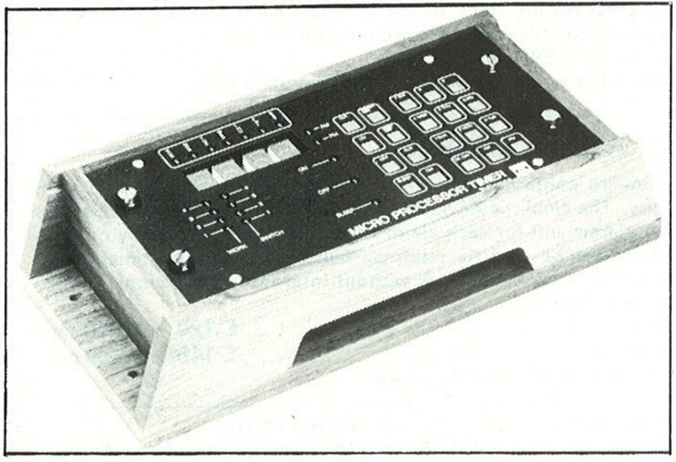

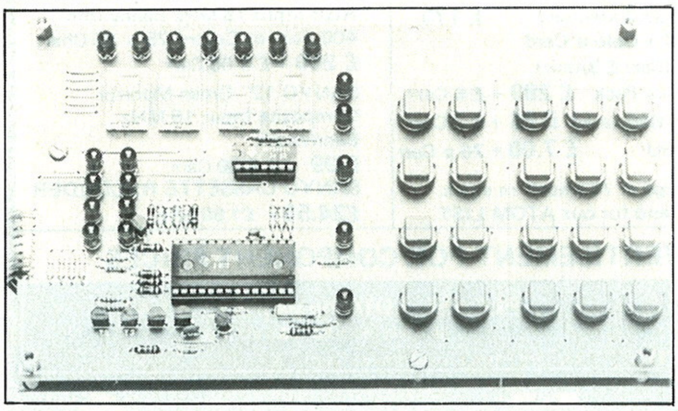

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Control switching:	*Standard relays will switch 2A (one supplied with kit) Additional relays may be ordered separately.*
Microprocessor:	*TMS 1122*
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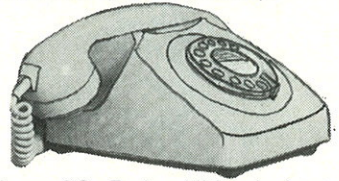

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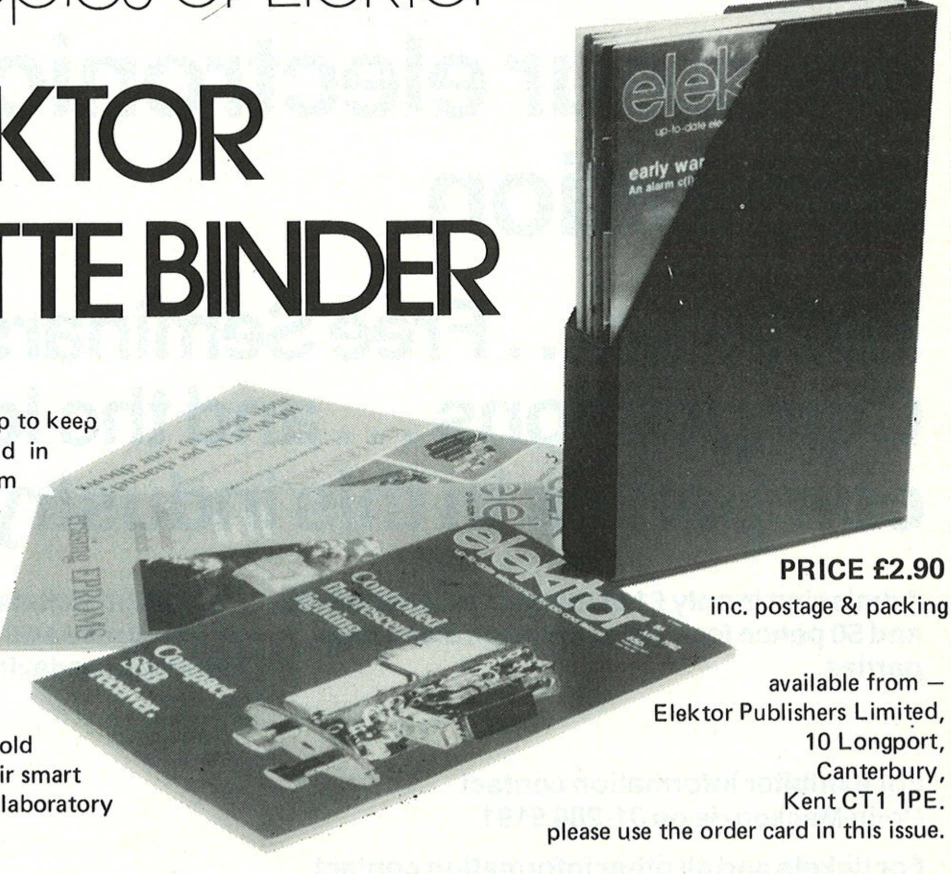

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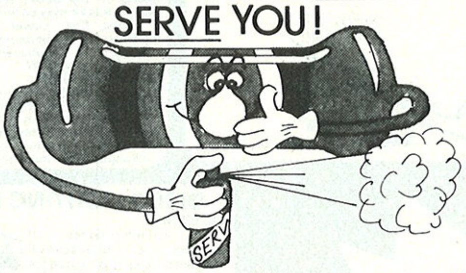

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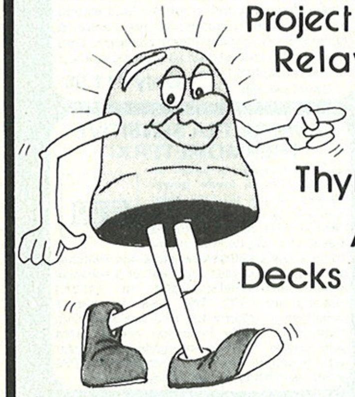

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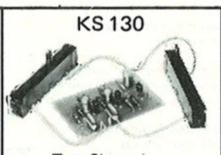

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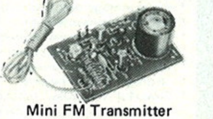

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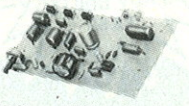

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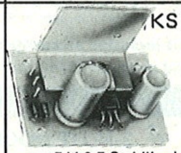

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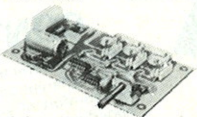

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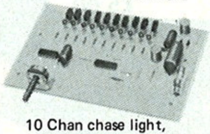

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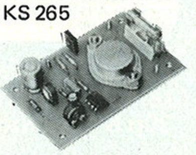

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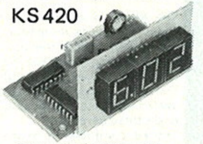

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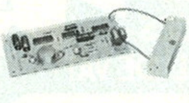

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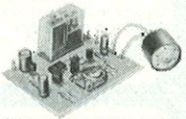

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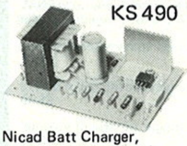

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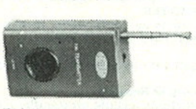

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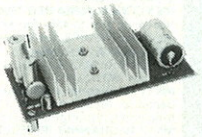

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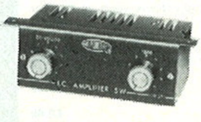

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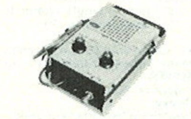

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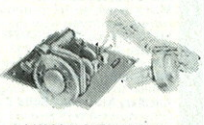

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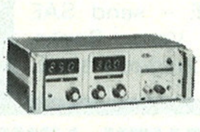
UK 666



Digital Power Supply 0-30 V 2.5 A
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UK 823/W

Car Anti-Theft Alarm, protects doors, boot bonnet & radio 12 V d.c. ready assembled
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UK 875

Capacitive Discharge Electronic Ignition
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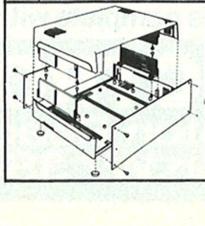


MODEL	OUTSIDE DIMENSIONS						PRICE
	WIDTH		HEIGHT		DEPT		
	INCH	mm	INCH	mm	INCH	mm	
00/3001.00	7,54	191,4	1,81	46	6,89	175	£3.80
00/3001.02	7,54	191,4	2,36	60	6,89	175	£3.80
00/3001.04	7,54	191,4	2,9	74	6,89	175	£4.75

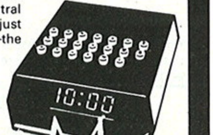
THE MULTI-PURPOSE TIMER HAS ARRIVED

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:-

- 0.5" LED 12 hour display.
- Day of week, am/pm and output status indicators.
- 4 zero voltage switched mains outputs.
- 50/60Hz mains operation.
- Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
- Display blanking during power failure to conserve battery power.
- 18 programme time sets.
- Powerful "Everyday" function enabling output to switch every day but use only one time set.
- Useful "sleep" function–turns on output for one hour.
- Direct switch control enabling output to be turned on immediately or after a specified time interval.
- 20 function keypad for programme entry.
- Programme verification at the touch of a button.

(Kit includes all components, PCB, assembly and programming instructions).



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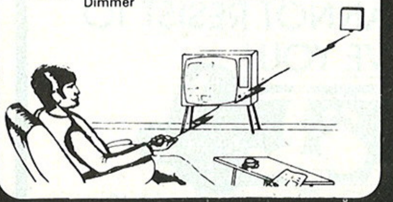
HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	**£14.30**
MK6	Transmitter for above	**£ 4.20**
TD300K	Touchdimmer	**£ 7.00**
TDE/K	Extension kit for 2-way switching for TD300K	**£ 2.00**
LD300K	Rotary Controlled Dimmer	**£ 3.50**



MINI KITS

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. 1KW **£4.00**

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.50**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the SL441 zero voltage switch, this kit may be wired to form a "burst fire" power controller, enabling the temperature of an enclosure to be maintained to within 0.5°C. Max. load 3KW **£5.55**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max. load 1KW. **£4.50**

♩ 3-NOTE DOOR CHIME ♫♩

Based on the SAB0600 IC the kit is suppied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS.
Order as XK102. **£5.00**

For a detailed booklet on remote control – send us 30p & SAE today.

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.
The kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

Only £23.75

Extra Solid State Switch Kits (XK104) and transmitters (XK105) can be supplied.

XK104 £2.40 XK105 £10.50

THE HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc. without rewiring your house. **JUST THINK OF THE POSSIBILITIES.** The KIT includes all PCBs and components for one transmitter and two receivers plus a pre-drilled box for the transmitter.

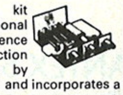
Order as XK112

£42.00

ALL PRICES EXCLUDE VAT

DISCO LIGHTING KITS

DL 1000K
This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **Only £14.60**



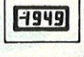
DLZ100K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1
Allowing audio ("beat")—light response. **60p**

NEW DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps. (1Kw/Channel) **Only £11.95**

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (–50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.



We have the SOFTY 2 EPROM programmer in stock at £169

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery. **£4.20**

MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

THE KEY TO YOUR SECURITY IS IN OUR LOCK

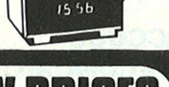
If the thought of car thieves, house breakers or people tampering with your electrical and electronic equipment upsets you, we have just the kit for you.
Our ELECTRONIC LOCK KIT includes 10-way keyboard and a special IC which provides a 750mA output to drive a solenoid or relay (not supplied) when four keys are depressed in the correct sequence. This gives over 5,000 possible combinations! The sequence is prewired and may be easily changed by means of a small plug and socket. A "SAVE" function is also available enabling the open code to be stored (especially useful in a car when it is left in a garage for servicing as the open code need not be disclosed). Size: 7x6x3 cms. Power Consumption is 40uA at 5V to 15V d.c.

At only **£10.50 + VAT**, it will make a smaller hole in your pocket than a bunch of keys!

Electric Lock Mechanism
Suitable for use with existing door locks and above electronic lock kit. **£13.50**

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.



CT1000K Basic Kit	**£14.90**
CT1000K with white box (56/131 x 71mm)	**£17.40**
(Ready Built)	**£22.50**

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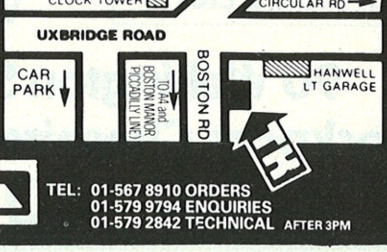

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services to readers

EPS print service

Many Elektor circuits are accompanied by printed circuit designs. Some of these designs, but not all, are also available as ready-etched and pre-drilled boards, which can be ordered from any of our offices. A complete list of the available boards is published under the heading 'EPS print service' in every issue. Delivery time is approximately three weeks.
It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

Technical queries

Please enclose a stamped, self-addressed envelope; readers outside UK please enclose an IRC instead of stamps.
Letters should be addressed to the department concerned – TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.

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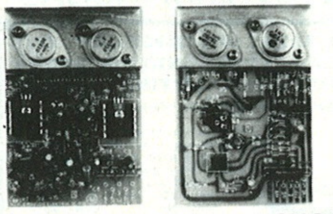

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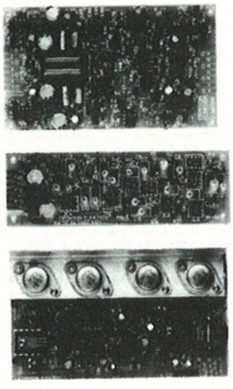

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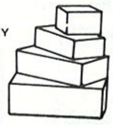

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CERAMIC Very small 1.8, 2.2, 2.7 etc. up to 1n **5p each**. 1n5, 2n2, 3n3, 4n7, 6n8, **5p**; 10n, 22n, **6p**; 33n, 47n, **7p**; 100n, **8p**.

POLYESTER, SIEMENS LAYER TYPE 7.5mm lead spacing 100V

1n, 1n5, 2n2, 3n3, **6p**; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n 27n, 33n, 39n, 47n, **7p**; 56n, 68n, **7p**; 82n, 100n, **9p**; 120n, 150n, **11p**; 180n, 220n, **12p**; 270n, 330n, 390n, 470n, **15p**; 560n, 680n, **24p**; 10mm spacing 1uF **25p**; 15mm spacing 2u2 **35p**; 22,5mm spacing 1uF 400V **50p**; 3.3uF 100V **69p**; In depth stocks.

ELECTROLYTICS
NON-polar (for LS X-overs) 50V peak 2uF **26p**; 4uF, **28p**; 6, 8, 10, 16uF, **32p**; 25uF, **37p**; 40, 60uF, **59p**; 100uF, **69p**.

POLARISED SIEMENS or MULLARD FOR QUALITY (uF/V) 1/63, 2.2/63, 4.7/63, 6.8/40, 10/25, 22/10, **10p each**; 10/40, 22/25, 47/10 **11p**; 47/25, **12p** 100/10, **13p**; 100/25, 100/40, **15p**; 220/10, 220/16, **16p**; 220/25, **18p**; 220/40, **20p**; 470/10, 470/16, 470/25, 1000/10 **19p**; 470/40, 1000/16, **27p**; 1000/25, **36p**; 1000/40, 2200/16, **44p**; 1000/63, **75p**; 2200/40, 4700/16, **73p**;

Pluggable SIEMENS single ended

1/63, 2.2/63, 4.7/63, **26p**; 10/63, 22/63, **22p**; 22/40, 47/16, **10p**; 47/40, **24p**; 47/63, **15p**; 100/16, 10/25, **12p**; 100/40, **15p**; 100/63, **20p**; 220/10, 220/16, 220/25, **13p**; 470/6.3, **15p**; 470/10, **16p**; 470/16, **18p**; 470/25, **22p**; 470/40, **25p**; 1000/10, **24p**; 1000/16, **23p**;

Large Cans – SIEMENS

2200/63, **£1.77**; 4700/40, **£1.78**; 4700/63, **£2.96**; 4700/100, **£5.54**; 10.000/16, **£1.93**; 10/25, **£2.78**; 22000/16, **£3.20**; 22000/25, **£4.73**.

TANTALUM

0.1/35, 0.22/35, 0.47/35, 1/35, 2.2/16, **13p each**; 2.2/35, 4.7/35, 4.7/16, 10/6.3, **16p**; 4.7/35, 10/16, 22/6.3, 10/25, **18p**; 22/16, 22/25, 33/10, 47/6.3, 100/3, **30p**.

LOW LEAKAGE All single ended

0.1/50, 0.22/50, 0.47/50, 4.7/35, **11p**; 1/50, 2.2/50, 4.7/50, **11p each**; 10/16, 22/6, **11p**; 10/35, 22/10, 22/16, 22/35, 47/6, 47/10 **12p**; 47/16, 100/6, **11p**.

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4006	50p	4018	45p	4030	16p	4072	14p
4007	14p	4019	25p	4041	44p	4081	14p
4008	40p	4020	42p	4042	40p	4082	14p
4009	24p	4021	40p	4043	40p	4093	20p
4010	24p	4022	35p	4044	40p	4510	46p
4011	12p	4023	14p	4046	46p	4511	46p
4012	15p	4024	32p	4049	23p	4516	53p
4013	20p	4025	14p	4050	23p	4518	40p
4014	46p	4026	80p	4060	45p	4520	60p

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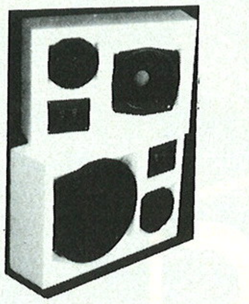

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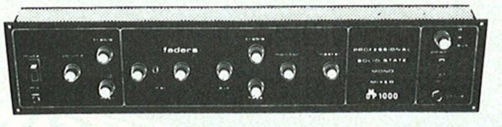

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Size 22½" × 4⅞" × 2½" **price £39.99 + £2.50 P&P**

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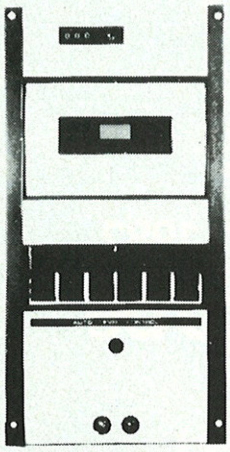

6 piano type keys

STEREO CASSETTE TAPE DECK MODULE.

Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity**: 100mV to 2V **Input Impedance**: 68K. **Output level**: 400mV to both left and right hand channels. **Output Impedance**: 10K. **Signal to noise ratio**: 45dB. **Wow and flutter**: 0.1%. **Power Supply requirements**: 18V DC at 300mA. **Connections**: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions**: Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
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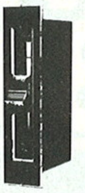

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- Easy snap in fixing through panel/cabinet cut out
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Innumerable applications in industry, the home, and discos/theatres etc.

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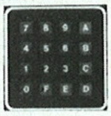
KEYBOARDS



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16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
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P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: **£28.50** + £2.50 P&P

NEW RANGE QUALITY POWER LOUDSPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price: –

15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each £3.00 Packing and Carriage each.**

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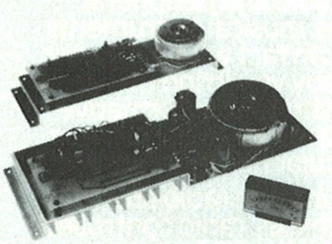

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Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz — 25KHz ±3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 × 115 × 72mm
OMP 300 460 × 153 × 66mm
Prices: OMP 110 **£31.50 each + £2.00 P&P**
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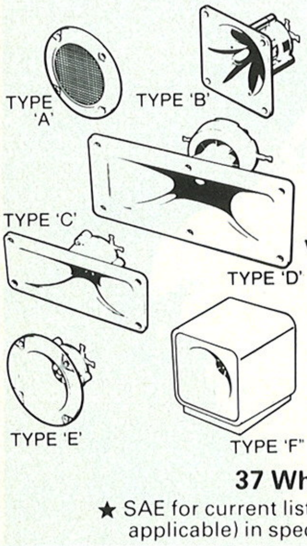
Vu Meter **£6.50 each + 50p P&P**

PIEZO ELECTRIC TWEETERS – MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



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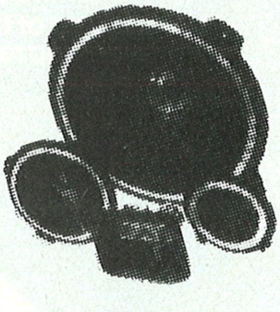
Build a quality 60watt RMS system 8ohms

Build a quality 60 watt R.M.S. system.



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- ★ **3" Tweeter 2.5KHz-19KHz**
- ★ **5" Mid Range 600Hz-8KHz**
- ★ **3-way crossover 6dB/oct 1.3 and 6KHz**
  Recommended Cab-size 26" × 13" × 13"

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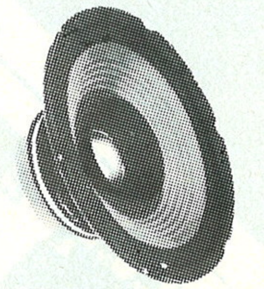
Price £22.00 per kit + £2.50 postage and packing. Available separately, prices on request.



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4081	0.12	4583	0.80	74LS107	0.25	74LS245	0.80
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4175	0.80	4585	0.45	74LS112	0.20	74LS258	0.37
4502	0.60	40174	1.05	74LS113	0.20	74LS260	0.50
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4506	0.70	74LS00	0.10	74LS122	0.35	74LS273	0.70
4507	0.37	74LS01	0.10	74LS124	1.80	74LS279	0.35
4508	1.50	74LS02	0.11	74LS123	0.35	74LS365	0.32
4510	0.55	74LS03	0.11	74LS125	0.24	74LS366	0.34
4511	0.45	74LS04	0.12	74LS126	0.24	74LS367	0.32
4512	0.55	74LS05	0.13	74LS132	0.42	74LS368	0.35
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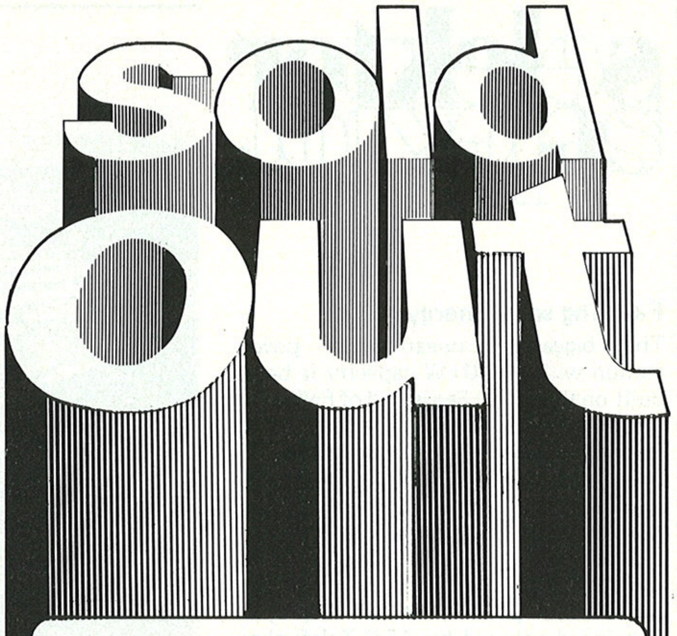

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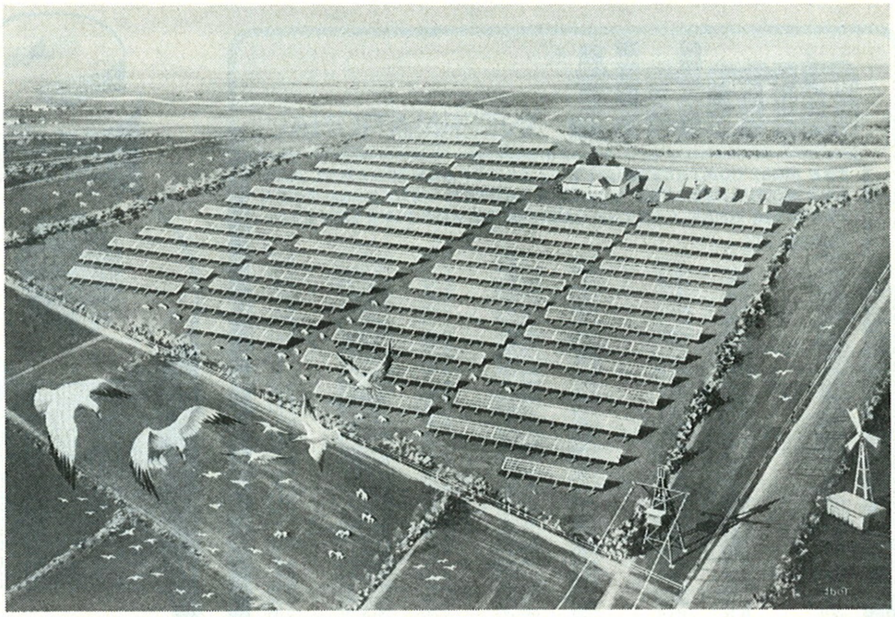
Farming solar energy

The biggest european solar power station with a 300 kW capacity is being built on the North Sea island of Pellworm in Schleswigholstien, Germany. The station is scheduled for completion in July 1983 and will provide the energy requirements for the convalescent home that is a feature of the island. The solar panels cover an area of roughly 16000 square metres which is equal to about two football pitches. The entire project is being developed by AEG Telefunken of Germany. The generator directly converts solar energy into electrical energy. Since the plant is built on farm land, and the land is still required, the total solar array is raised about one metre above ground level allowing the area to continue to be used for sheep grazing. The three million pound project is financed primarily by the German Ministry for Technology and the E.E.C.

The entire project is being treated as an experiment and if it is successful the lessons learned will be used in the construction of further solar power stations with power outputs up to 2 MW. Long term reliability with low maintenance costs are the prime objectives being sought. The solar experts of AEG have gained considerable experience in the third world countries where energy from solar sources is extremely important.

The island of Pellworm is the site of a large convalescent centre and for this reason solar energy is well suited. Paradoxicaly, the energy requirements of the hospital is greater in the summer months than in the winter. Battery storage units are used to cater for energy use at nights and periods of poor weather. The solar farm is capable of providing more energy than is required and the surplus provides assistance to the regional grid system.

Today the cost of 1 kWh of solar energy is about £ 0.50 and AEG consider that this could be reduced by 1986-88 to about 7 p per kWh, a very considerable saving. This is not the first venture of this type that AEG have developed in Europe. Two others, both 50 kW installations, are a milk farm in Ireland and a naval college in Holland. One aim of these developments is to be sure of an energy supply to provide an export potential to areas like the third world countries. It is believed that by the year 2000 a good proportion of the worlds power will be provided by solar means.



Storage capacity of 6000 Ah

The construction of the present solar farm used standard industrial components. The solar generator itself consists of 15840 modules which are divided into 22 switchable sub groups. The solar panels are mounted at an angle of 40° by a framework consisting of zinc plated steel and tropical hardwoods. The rated output of 48 modules in series is 346 V and each subgroup of modules can be switched onto 2 d.c. busses by computer control. Each bus is connected to a battery having a storage capacity of 3000 Ah. During normal use half of the battery provides the power supply to the hospital while the other half is being charged by the solar array. When the level of the battery being charged reaches a maximum, the solar energy is diverted into the section which is in use. This is illustrated in figure 1. The graph in figure 2a shows the average sunlight levels recorded during 1972-1980 in the area.

The batteries are of sufficient size to cater for the eventuality of a number of consecutive days when the sunlight is not enough for the energy requirement. Hence 6000 Ah batteries. In the worst situation the drain would still not exceed 70% of the capacity. The battery packs are built using very high quality industrial accumulators each having a 10 hour capacity of 1500 Ah with a rated 2 V. To achieve this four groups each with 173 cells in series are needed which in effect cover an area of 1000 square metres and having a total weight of 120 tons. Although the batteries are highly efficient in order to ensure a long life span, they are treated very gingerly by the computer control and as a result maintenance is virtually zero.

Another reason for less maintenance is the use of recycling caps fitted to the top of each cell, which means no topping up with distilled water is ever necessary.

These caps contain a catalyst which cause the separated gasses (hydrogen and oxygen) to recombine to form water again, returning it to the electrolyte.

Connections to the regional grid

The d.c. output of the system is fed to the regional a.c. grid via a mains static converter. This converter is only operational when the solar source is connected to the mains grid. In the case of a power failure in the regional grid the solar source is inherently protected by the mains coupling. In effect if the mains source fails, the converter is automatically switched off preventing the heavy drain which would occur, therefore 'spark suppression' is also catered for in the event of deshort-circuiting. Because the converter is mains controlled the normal synchronisation problems are not encountered. The converter is designed to handle 300 kW.

Another function of this converter is to charge the batteries should a breakdown occur to the 'solar system', or if insufficient power is produced due to continual poor weather.

Inverters for the hospital

Obviously the hospital also requires an a.c. supply, therefore 2 inverters are used through which the solar d.c. supply is fed. These are rated at 75 kVA. The result is a usable 220 V 50 Hz supply. Inverters as opposed to other types of conversion are used simply because they are very efficient. At low consumption times like night time and the off peak season only 15% of the total rated power supply is normally needed, but even at these levels the inverters operate at 87% efficiency.

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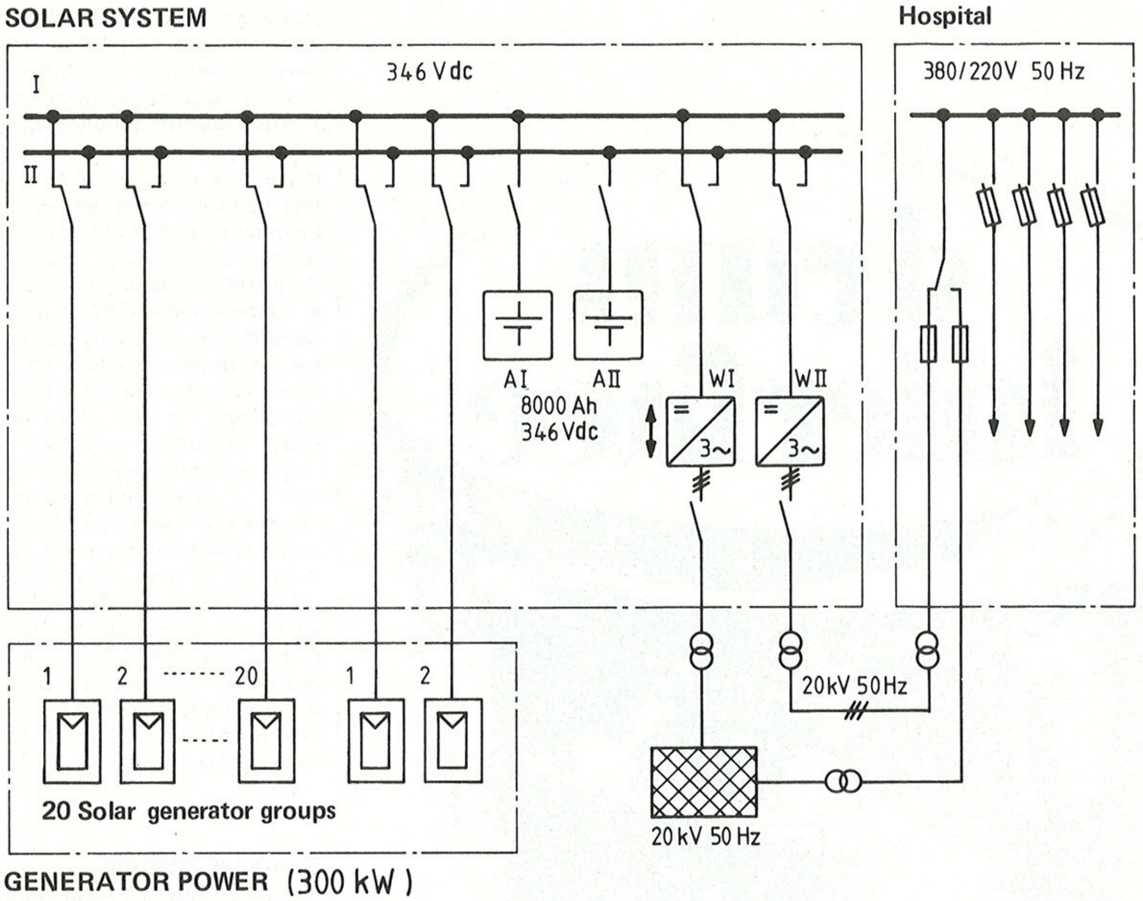
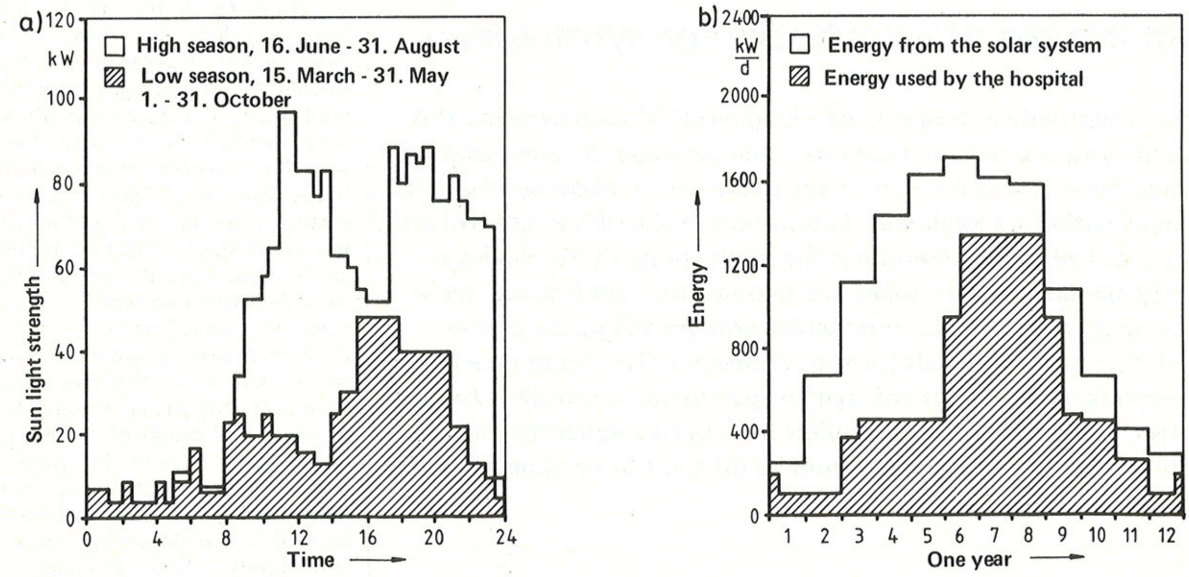


I: The diagram of the complete installation.
AI, AII: battery packs.
WI: the static converter.
WII: the inverter.
I and II: the solar panel arrays.

2



The facilities which are supplied by this system include a restaurant, sauna, physiotherapy installation and indoor swimming pool. The inductive load is created by several 5.4 kW motors and the resitive load by the sauna heating system which is rated at 18 kW. The control, data collecting and handling and recording centre uses a microprocessor. This is because, as the development is an experimental one, as much flexibility as possible is required. One of the targets of the program is to optimise the efficiency and therefore the economics of the complete system. The processor also controls the switching of the static converter and determines the nominal energy level which is supplied to the regional grid.

Basically this experimental development is a good way for amassing data in order to plan future systems capable of delivering power within the mega watts range.

drum interface

G. Lausberg

a drum instead of a keyboard for synthesizers

Why must a synthesizer always have a keyboard? Musicians asked this question of synthesizer manufacturers some time ago. In the meantime there is a considerable number of 'controllers' which allow synthesizers to be played without a keyboard. In addition to the ribbon controllers, with which a steel string determines the pitch (similarly to playing a violon), the percussion controllers are amongst the best known: these are drums with internal electronics which convert the pulses of the drumstick into control signals for the synthesizer. The drum interface is the electronic circuitry for this type of percussion controller. As pop music specialists know, such controllers have been frequently used in recent recordings. 'Disco drums' would be difficult to imagine without this effect.

The most complicated part of a drum controller is the drum itself; the electronic circuitry could almost be accommodated in a matchbox. This compact circuit, however, produces astonishing results: staccato synthesizer sounds in a drum rhythm allowing wide variation. "Playing" the synthesizer with a drum makes the synthesizer far more accessible to many more people: instead of a keyboard there is only one, albeit somewhat unusual, "key" — the drum and a drumstick. This key can be played with great sensitivity. The drumbeat rhythm delivers the triggering pulses and hence the rhythmic structure of the synthesizer action. The dynamic (variable) component is the drumbeat intensity which the drum interface converts to a proportional voltage. This voltage can be applied with great versatility: to control the pitch, filter frequency or amplitude of the synthesizer, depending on whether the drum control voltage drives VCOs, VCFs or VCAs. Apart from the fact that the drum makes the synthesizer accessible to everyone (playing it becomes fun), different and tightly controlled sounds can be obtained from the synthesizer with a little practice.

Simple electronics

There is nothing secret about the way the drum interface operates, on the contrary it is refreshingly simple. The interface begins with a transducer in the form of a microphone or loudspeaker which converts the sound in the drum (or in its immediate vicinity) into an electrical signal. This signal exhibits the characteristic of a damped sinusoidal oscillation whose frequency depends on the drum and whose amplitude depends on the drumbeat intensity. The purpose of the circuit in the block diagram of figure 1 is to act as an interface by processing this signal for the synthesizer. Required at the output are a triggering pulse (gate pulse) and a variable control voltage.

First the signal from the microphone or loudspeaker is greatly amplified. A trigger circuit at the amplifier output generates triggering pulses from the negative half-waves of the signal; these pulses can already be used as gate pulses. However, they also trigger two monostables in the interface which control an analogue memory (sample and hold). This analogue memory accepts the maximum amplitude of the positive half-waves and holds it until the next drumbeat. Thus each drumbeat provides a triggering pulse and a new control voltage. What could be better?

The circuit

Figure 2 shows the practical implementation of the principle sketched in the

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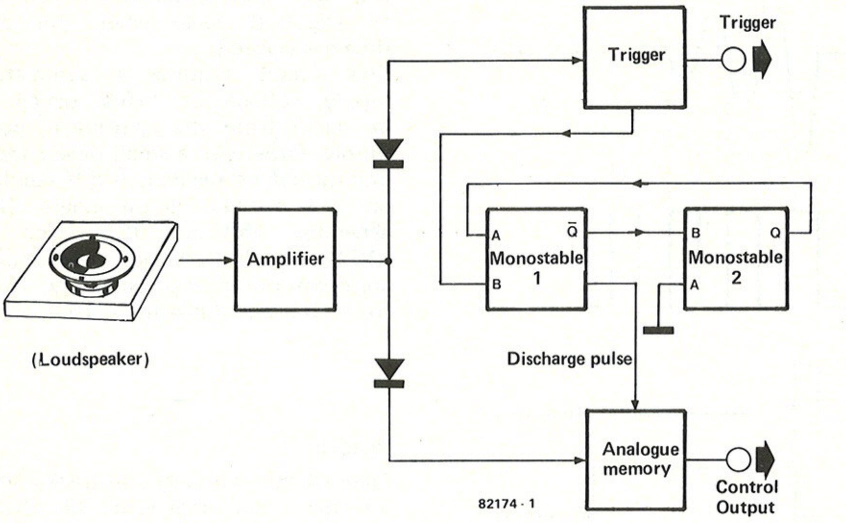

Figure 1. Block diagram of the drum interface. The transducer is a loudspeaker or microphone. From the drum signal obtained in this way, a trigger pulse with each drumbeat. An analogue memory holds the maximum amplitude of the signal with each beat. The result is a control voltage whose amplitude depends on the drumming intensity.

2

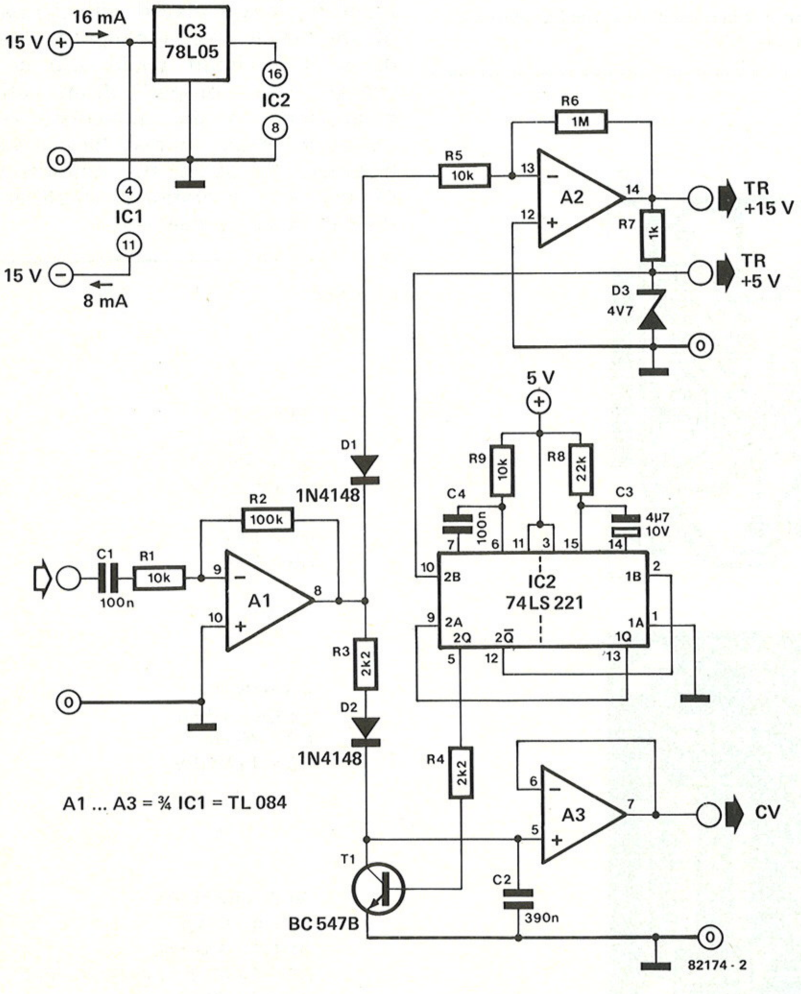

Figure 2. The circuit of the drum interface is simpler than the block diagram implies: the main components are only two low-cost ICs.

block diagram (figure 1). The components required are basically only two ICs: IC1 contains four operational amplifiers, only three of which are utilized; IC2 provides the two monostables. The first operational amplifier serves as an amplifier for the drum signal from the pick-up (loudspeaker or microphone). The amplification is fixed art 10 x, by means of the negative feedback loop R1/R2. It can be varied by using a trimmer potentiometer instead of R2. The low-impedance input of the circuit is intended for connecting loudspeakers and low-impedance microphones (dynamic or electret with integral impedance converter). At the output of A1, two diodes (D1, D2) split the signal path: one for positive and one for negative half-waves. The negative half-waves are fed via D1 to another amplifier A2, which overdrives on account of its very high amplification (100 x) and delivers square-wave pulses at its output. At output TR these pulses have an amplitude of + 15 V and at output TR their amplitude is + 5 V. Thus suitable gate levels are provided for all common synthesizers. The fact that a whole train of pulses appears at the gate output for each drumbeat does not normally cause any problem, because the envelope generators of the synthesizer only trigger on the first leading edge and then allow their envelope to develop without being affected by subsequent triggering pulses. Should there be a problem, however, the signal at pin 9 or pin 13 of IC2 can also be used as the + 5 V gate pulse. As shown in the pulse diagram of figure 3, a longer pulse is present at these points, which only appears once per drumbeat. IC2 is a TTL dual-monostable. The first monostable triggers on the pulse from output TR + 5 V, which is connected to pin 10 of IC2. This first monostable generates a short pulse at its output pin 5 which turns on transistor T1. This causes capacitor C2 to discharge with the first half-wave of the drum signal. When this discharge pulse has ended, T1 turns off again; capacitor C2 is now ready for charging and accepts cia diode D2 the peak voltage of the next positive half-wave from the output of the input amplifier. D2 prevents a discharge of the capacitor and the voltage is maintained until the next drumbeat. The high input impedance of the operational amplifier A3, which is utilized as a buffer for capacitor C2, caters for adequate stability of the storage stage. A buffered control voltage (CV) is present at the output of A3.

The second monostable with the longer pulse ensure that the first monostable only responds to the first pulse at its input with each drumbeat. This rejection of subsequent pulses is explained by the pulse diagram: the first monostable pulse is present in inverted form at pin 12. This output is connected to input pin 2 of the second monostable, which therefore triggers on the trailing

3

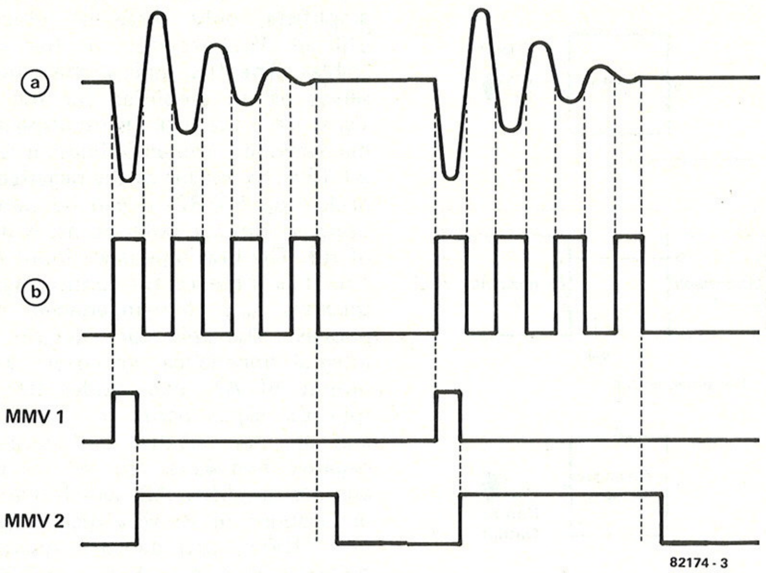

Figure 3. Signals at various points in the circuit:

- **a. The drum signal, a damped sinusoidal oscillation.**
- **b. Triggering pulses at the gate output. These are produced by limiting (clipping) the negative half-waves of the drum signal.**
- **c. Output of monostable 1. These pulses discharge the capacitor of the storage stage before a new value is accepted.**
- **d. Output of monostable 2. This pulse blocks monostable 1 when the first pulse has elapsed, in order to prevent retriggering by subsequent gate pulses (b).**

4

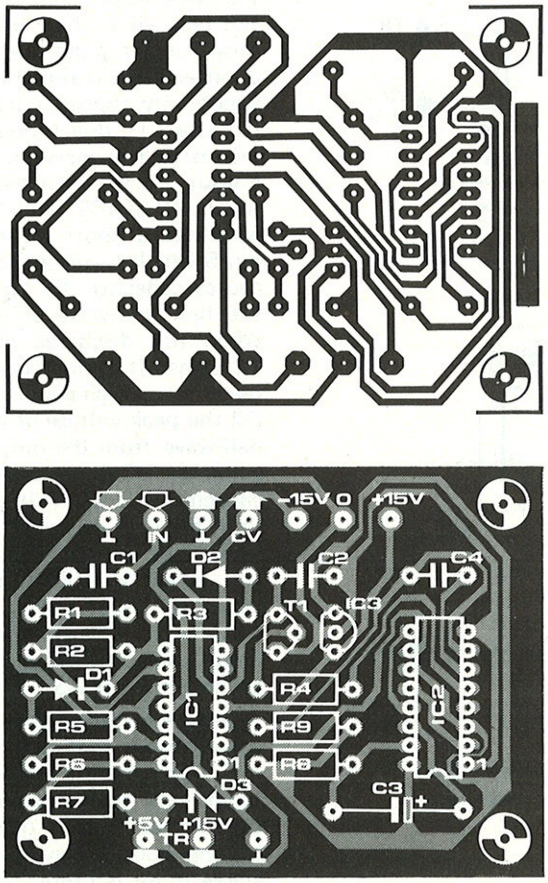

Figure 4. A suggested printed circuit design.

edge of the signal of monostable 1 and then supplies a longer pulse at output pin 13. Via pin 9, this pulse inhibits the first monostable which can only be triggered again when this pulse time has elapsed.

The circuit requires a symmetrical supply voltage of ±15 V which can be taken from the synthesizer power supply. Otherwise a small power supply unit would be needed. A 5 V regulator on the printed circuit board (IC3) generates +5 V for IC2 from the +15 V supply voltage. The current consumption is approximately 16 mA for + 15 V and 8 mA for − 15 V.

Practice

Figure 4 shows a suggested track pattern for the drum interface. All that is missing is a suitable percussion instrument. We found a very simple solution in the Elektor Laboratory: a standard, round loudspeaker of 18 cm in diameter was put to use; plastic foil was stretched over it as a drumskin. With this arrangement the output voltage at the CV output was between 1 and 5 V, depending on the drumming intensity; it was played with the palms of the hands like a conga or bongo drum. The circuit could also be installed in a "proper" drum with a microphone in the immediate vicinity of the drum. It may be necessary, however, to adapt the amplification of the first operational amplifier to the particular arrangement.

Parts List

Resistors:
R1,R5,R9 = 10 k
R2 = 100 k
R3,R4 = 2k2
R6 = 1 M
R7 = 1 k
R8 = 22 k

Capacitors:
C1,C4 = 100 n
C2 = 390 n
C3 = 4μ7/10 V

Semiconductors:
T1 = BC 547B
D1,D2 = 1N4148
D3 = 4V7/400 mW zener diode
IC1 = TL 084
IC2 = 74LS221
IC3 = 78L05

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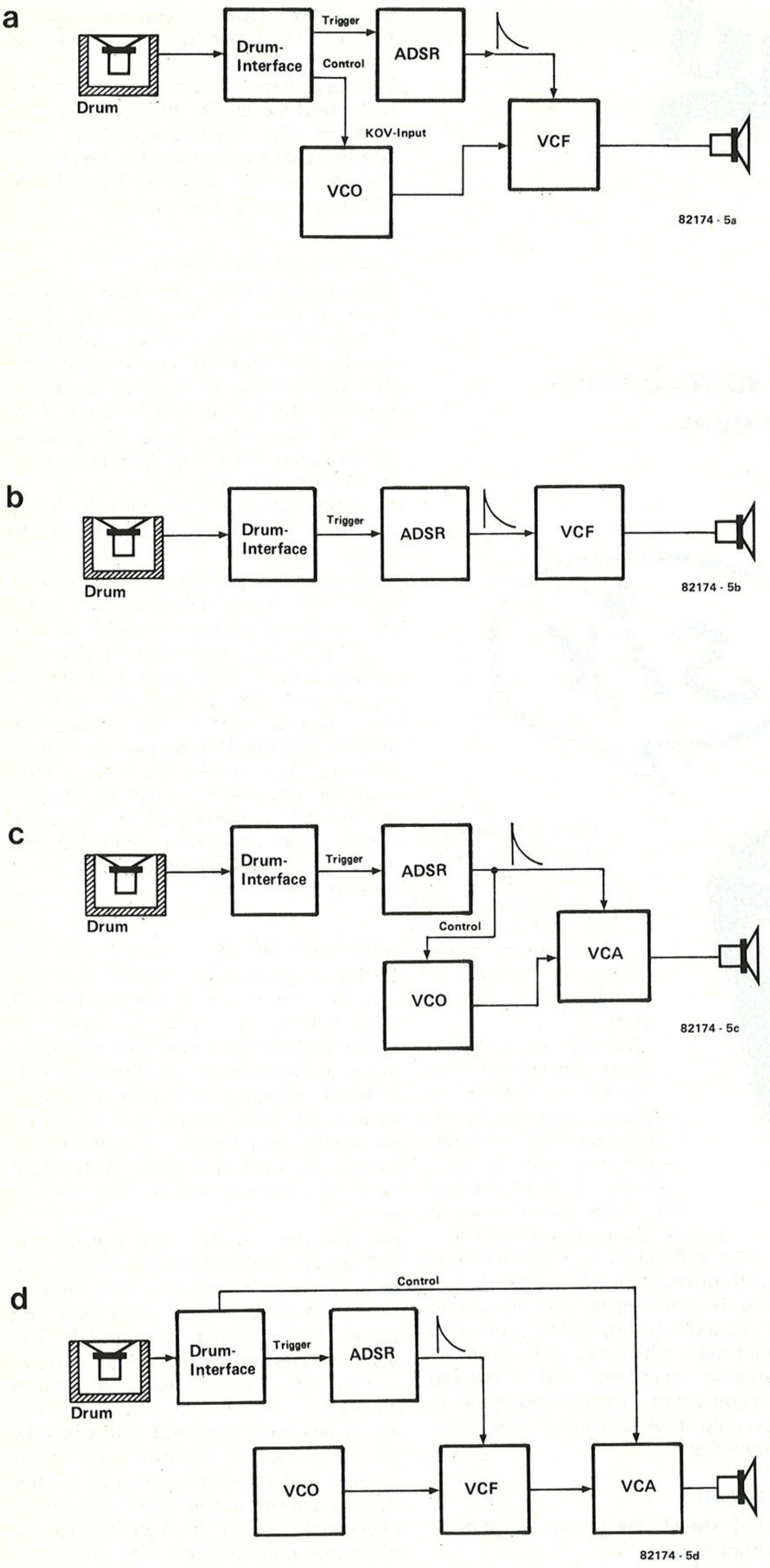


Figure 5. Examples for using of the drum interface with a (modular) synthesizer.

Methods of playing

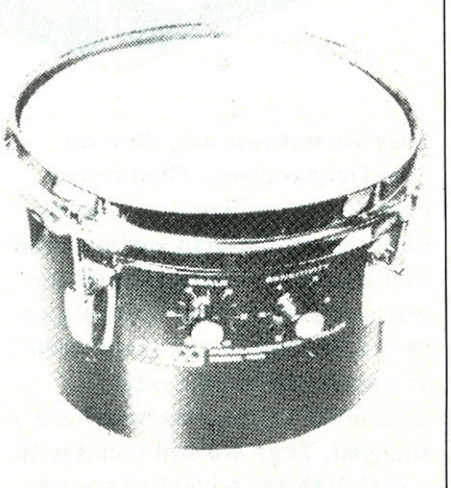
As with a keyboard, the control signals "CV" and "gate" can be used with great versatility for producing sound with the drum interface. In the following section we would therefore like to present in diagram form some of the methods of playing that were tried out (see figure 5).

The drum interface can be connected to the synthesizer instead of the keyboard. If the synthesizer has terminals for external gate pulse and external control voltage, these can also be used; in this case the keyboard can remain connected.

With the drum interface instead of a keyboard, all adjustments can be tried out on the synthesizer which more or less apply to the keyboard. Driving the VCO with the "CV" of the drum interface (figure 5 a) results in a new pitch with every drumbeat. The effect obtained is similar to that with a sample and hold circuit (random value generator 1). The "disco drums" effect is achieved by driving as shown in figure 5 b: the triggering pulse from the drum interface triggers an ADSR generator which, in turn, drives a VCF; the latter is adjusted as an oscillator with natural oscillation. The ADSR is adjusted as follows: attack, zero; decay, any; sustain, maximum; release, any. The effect is a sudden sinusoidal sound with decreasing pitch and amplitude during the decay. If a non-oscillating VCF is available, the same effect can be obtained by driving the VCO with the envelope curve, as shown in figure 5 c.

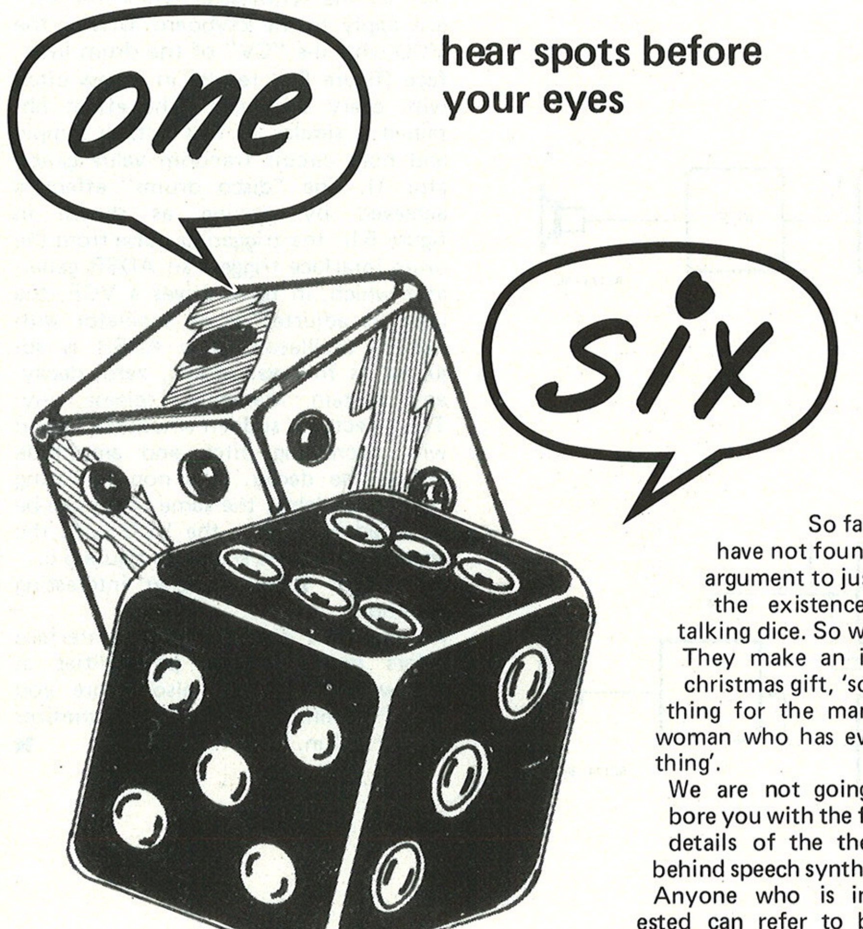
Figure 5 d shows another interesting variation.

As one can see, the drum interface offers many creative possibilities at a low cost. We can also assure you that "drumming" with the synthesizer is a lot of fun. ◄



talking dice

hear spots before your eyes



Dice are not just old, they are positively ancient! Their origin must lie somewhere in the mists of antiquity. Roman soldiers used them; gamblers from all over the world use them; even Chancelors of the Exchequer use them. Well, at least it seems that way!

Over all this time dice have hardly changed. They are still cubes with spots. With the advent of speech synthesisers, however, the road lies open to revolutionary dice: talkers!

So far we have not found an argument to justify the existence of talking dice. So what! They make an ideal christmas gift, 'something for the man or woman who has everything'.

We are not going to bore you with the finer details of the theory behind speech synthesis. Anyone who is interested can refer to back issues of Elektor. A list of the more useful ones is given at the end of the article.

The TMS 5100 is a sophisticated 'Voice Synthesis Processor (VSP)'. In a nutshell, it generates human speach and other sounds by digitally processing encoded data, which has been stored in non-volatile memory. The processed data is converted into an audio signal by the on-chip D/A converter and push-pull amplifier.

The circuit

Figure 1 shows the circuit diagram of the complete unit.

Starting with the section around the VSP: T1 and T2 form an audio amplifier. This is necessary because the internal amplifier of the IC delivers insufficient power to drive a loudspeaker. C2 acts as a ripple filter. Potentiometer P2 adjusts the volume. The TMS 5100 contains an oscillator that provides the necessary clock pulses (160 kHz at pin 3 of IC1). Only three external components are required (R5, C1 and P1). The setting of P1 determines the clock frequency.

The rest of the circuit consists of a control interface (IC2); the memory that contains the vocabulary (IC5); the address decoder/counter IC4; and finally the counter IC6 and the data selector (the actual number generator) IC7.

Counting and initialisation

As a result of depressing S2 a sequence starts, as shown in figure 2a. First IC1 is initialised by pulses coming from IC2. IC2 is reset (line Q0 becomes logic 1). The pulse from S2 is inverted by T3 (logic 0) and fed to the $\overline{\text{CI}}$ input of IC6. This IC now 'selects a random number' by counting the pulses supplied by the ROM/CLK output of IC1.

Releasing S2 stops IC6, since the 'carry in' input of IC6 (pin 5) is returned to logic 1.

Now we come to the second phase. This starts with the initialisation of IC1 by the combined pulses supplied by IC2 (see figure 2a). Two PDC pulses are followed by a third, and between the second and third pulse IC4 is reset to zero. Going back to the circuit, the address counter IC4 is reset as a result of a logic 1 at pin 11 caused by a pulse from line Q5 (pin 1) of IC2. Output Q9 of this IC is connected to its clock enable input. As a result when Q9 goes 'high' IC2 stops counting, until S2 is pressed again.

Now you're talking

So far so good, but the VSP is still at loss for words. At this point, the I/O output from IC1 sends a 'burst' of pulses to IC4; the latter then outputs a series of addresses to the EPROM. This EPROM contains the data shown in table 1: all speech information for the six words in a kind of 'parallel serial' format. Line D0 gives data for the word 'one', D1 corresponds to 'two' and so on.

As described earlier, the outputs of IC6 specify the desired number. The demultiplexer IC7 now selects the correct data output line from IC5 and passes this bit stream to output X. The VSP receives this data on line ADD8, whereupon it pronounces the random number.

We have made repeated references to the fact that the number is picked at random. The reason for this is that IC6 is counting the clock frequency (160 kHz), which is high enough to deter would-be cheaters. The counter is set to count from 2 to 7, as shown in figure 2b. When output Q3 (pin 2) of IC6 goes 'high', the preset enable input (pin 1) is activated. Preset inputs P0 . . . P3 are wired in such a way that

1

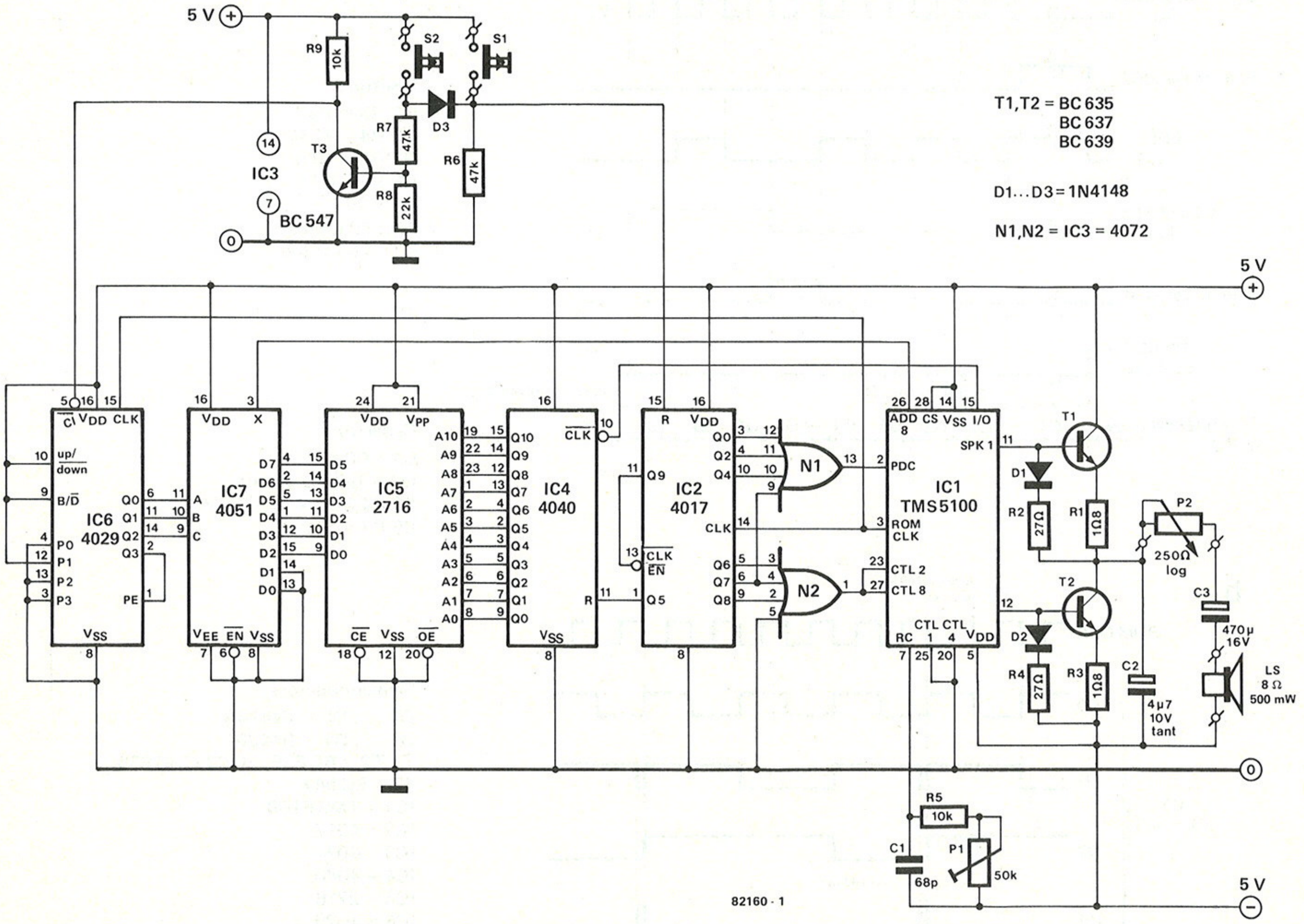


Figure 1. The circuit diagram of the Talking Dice using the TMS 5100 speech synthesiser. A ready prepared EPROM 2716 with the vocabulary is available. Switch S2 picks a random number, and S1 gives an instant replay.

Table 1. The Hexdump of the 2716 EPROM.

```
HEXDUMP:
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F    160: DC C6 CB DC C3 FF CA CE DE DD D6 CA DD D3 E8 F7
000: FF C0 F3 CD CD C0 C1 C0 C1 C0 C0 C2 FE F8 FD DA    170: F2 CE DD F7 D0 EE DF F0 D8 E7 E2 CD D8 FB E3 F2
010: C1 DF C6 DB C6 C1 FE DD D0 E9 D6 C7 F2 C0 FA DE    180: CA FD FE C6 E7 C8 C1 D9 D7 D5 CE F7 E8 E5 D6 CB
020: E7 C0 C1 C0 C1 C1 C0 E2 FC E6 DB FF C0 E7 FF C8    190: CB CD D6 D3 F9 F7 E6 CF EB DA F9 E4 DA E4 D7 C8
030: F7 C3 DD F6 FB C2 FE ED D0 C0 FF F0 EE CC C1 C0    1A0: F7 EE C3 F8 F3 C4 F9 CA D1 CF F1 CC CD DC D7 CB
040: C0 C1 C1 ED F3 FE D5 D0 E2 DD FD DC FA C1 F6 F8    1B0: DA FA F8 F3 EF C7 CC D5 D9 C6 D4 FE FC D9 C5 CF
050: DE C1 FF E0 FD DA FF E8 D3 C0 DF CC C9 C4 D9 E1    1C0: C3 D6 D9 C2 E7 ED F3 F3 EA EF CA EA D7 D3 C9 F0
060: F6 E5 EC E7 F8 C3 F9 CE C1 D2 E0 EC E1 FA CC D5    1D0: FD ED E4 C3 CB C4 C1 DC FC D5 FD CD CF D1 CA C5
070: DB D4 EB EB EF E3 DC C7 D2 C0 DF DD EE FB C2 F6    1E0: E9 FE E2 ED C3 D5 CE DB D0 D5 DF DA C0 C4 F1 D7
080: C8 D2 DD CD DA D7 F6 DF F9 C2 CF D0 CF CB C6 EB    1F0: EB C8 D5 E9 C0 D0 C8 D0 DB CE C9 FB EC F2 F3 C0
090: E2 F6 E1 EC D5 F8 E7 F6 EB C3 FC EE EC DC F3 FC    200: F6 D8 CB E6 C5 CC E3 CA F4 C1 F6 F9 CA C6 E5 D9
0A0: E7 F9 C0 FD F6 DC C0 FE E6 F1 D2 CE EC FB DD E0    210: D0 C5 DD C6 CD CB D3 E0 F9 EA F3 C3 F1 C8 DE C1
0B0: D6 EA F3 DC DC CB E7 FC F2 DB E0 EA D5 CD ED E2    220: C7 D9 F2 CD EF C0 EA E8 C0 D1 EB EB E4 C7 CD CC
0C0: C0 E2 D7 C9 E4 F5 D0 FF C6 EA F6 D9 C2 ED DD DF    230: CB C7 DB EF F0 E1 CC D7 C8 F4 E1 CA F9 E9 C7 C6
0D0: EC E3 F1 E9 F7 C2 FC D0 E6 EF F4 D3 ED FC F9 DA    240: D0 E2 C9 C1 C3 D0 EB E2 EC C9 CE C7 CB C9 D4 F7
0E0: E6 C7 EE F2 E9 D8 EE E6 F5 DA CF C2 F8 F3 EA EC    250: E9 E0 CE D3 F4 DA C6 DE C8 E1 D7 D9 E6 EC C3 D9
0F0: C3 E9 F6 F2 C1 C8 F6 F1 EB EF CE F2 F2 DF CD E8    260: F0 FB D8 CF CB C4 C2 CA C9 CC CE EE E7 C2 D0 E6
100: F5 DA C1 EC FC C2 F5 DA E5 F7 EF D1 EC C3 F6 F1    270: D7 E1 FD C2 E6 E7 C4 C6 C2 E1 C5 C6 FF D9 FF E9
110: C2 D4 E5 FD C2 FD FE E1 E9 DB C0 DC F6 DD D3 C8    280: C3 E9 C5 CA C6 C0 DE EE C8 F0 E8 C4 DA E6 FF E8
120: CC DB E9 F4 F2 CE F2 C7 D0 F9 FD C2 CE D2 FF CC    290: D5 C0 E7 E4 C6 C2 C4 F2 FA D0 CE DD E5 F6 DA E3
130: E8 E2 FF E8 F5 CA CE F3 DB D0 E0 E9 D7 CC F6 E1    2A0: DE C1 ED FD DF C0 DB F4 CE C2 DF F9 D7 E6 C1 E5
140: D7 CC D7 D4 EE DF D5 E8 E6 D4 FB E4 FF F6 C7 D2    2B0: E3 C2 C2 D4 F8 DC EA EB F6 E9 FF CD DC C5 F9 FE
150: EF DC C9 EF F8 F1 E5 FF C5 E3 DC DC C2 C5 DC D2    2C0: E9 C5 DA F5 F9 CD DB F4 C8 C2 CB E4 C5 E6 EE F0
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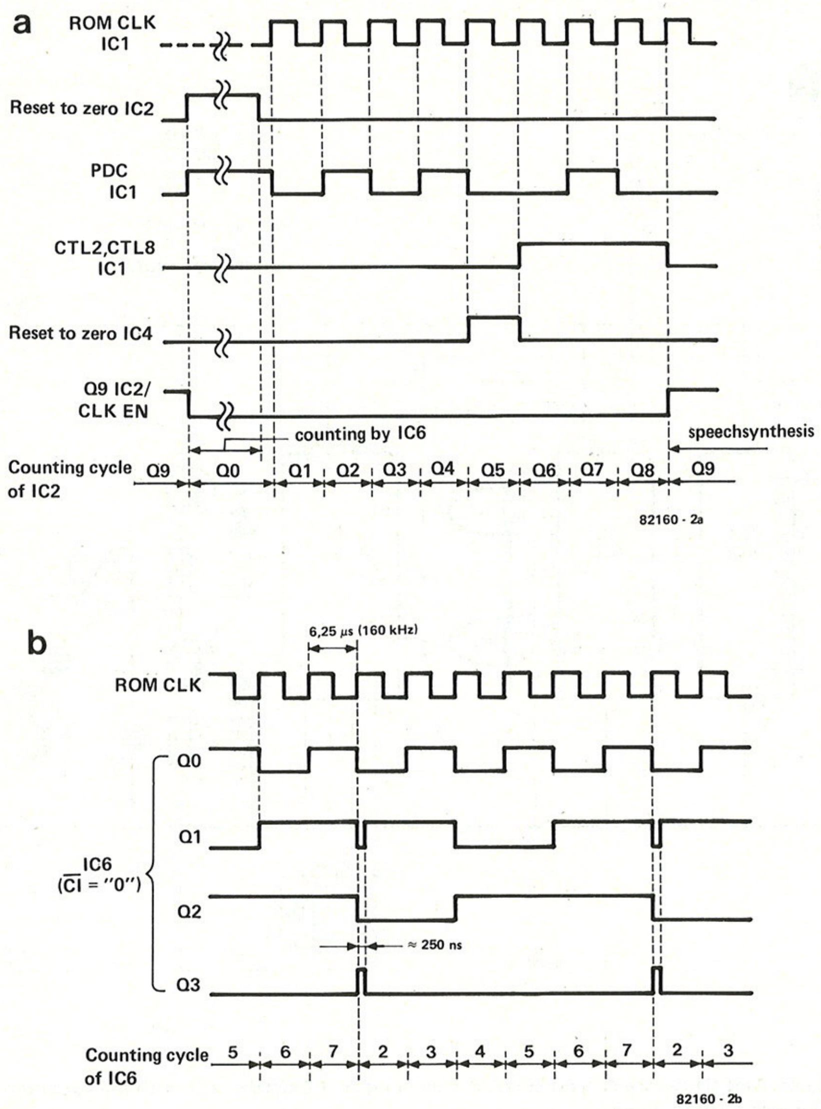

Figure 2. The various control signals, which must be applied to enable the circuit to work effectively.

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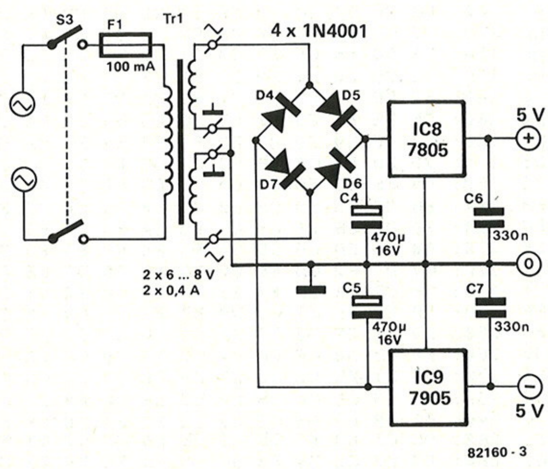


Figure 3. The circuit diagram of the power supply.

Parts list

Resistors:
R1,R3 = 1Ω8
R2,R4 = 27 Ω
R5,R9 = 10 k
R6,R7 = 47 k
R8 = 22 k
P1 = 50 k preset
P2 = 250 Ω log.

Capacitors:
C1 = 68 p
C2 = 4µ7/10 V tant.
C3,C4,C5 = 470 µ/16 V
C6,C7 = 330 n

Semiconductors:
D1 . . . D3 = 1N4148
D4 . . . D7 = 1N4001
T1,T2 = BC635, BC637, BC639
T3 = BC547
IC1 = TMS 5100
IC2 = 4017
IC3 = 4072
IC4 = 4040
IC5 = 2716
IC6 = 4029
IC7 = 4051
IC8 = 7805
IC9 = 7905

Miscellaneous:
S1,S2 = pressbuttons
S3 = 2 pole - 2 way
F1 = 100 mA slow-blow fuse
Tr1 = transformer 2 x 6 . . . 8 V/2 x 0,4 A
loudspeaker 8 ohm/0.5 W

the counter always returns to the number two. This method using a synchronous counter, ensures that all numbers have an identical (one in six) chance of occuring.

Say that again!

If in the heat of the moment (while playing), someone does not hear the answer from the dice, simply depress S1 and the number just 'thrown' will be repeated. In effect, S1 does the same job as S2, as far as IC2 and the speech synthesiser are concerned. However, D3 prevents it from enabling T3, so the

4

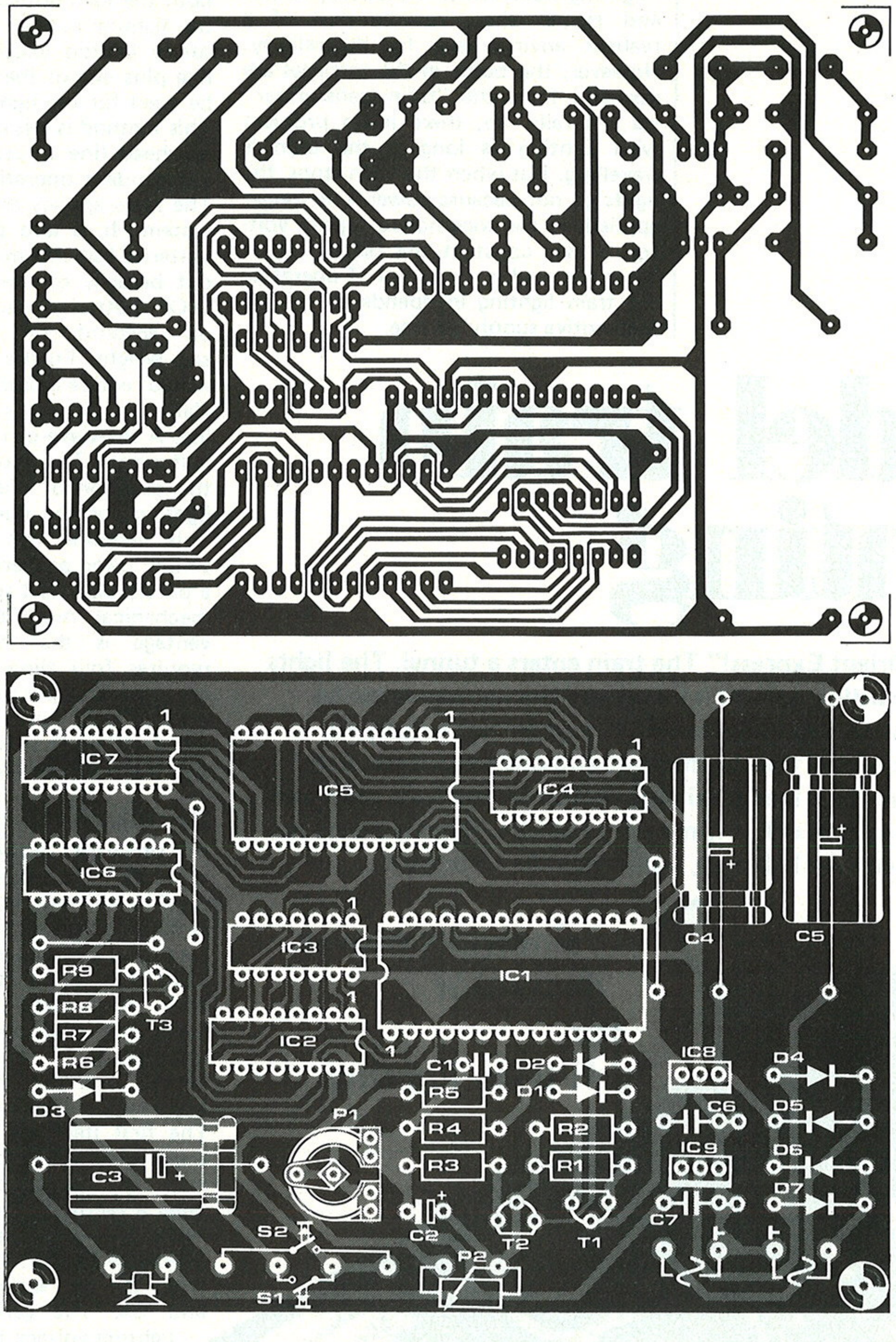


Figure 4. The printed circuit board for the talking dice and the power supply, as shown in figures1 and 3.

counter (IC6) remains in its current position.

Power supply

Figure 3 shows the power supply, using a normal three-pin voltage regulator. The CMOS ICs and the EPROM only require a positive 5 V supply, but the TMS 5100 needs a negative supply as well.

Construction and calibration

Figure 4 shows the printed circuit board for the complete circuit. No provision has been made for mounting the transformer, switches S1 . . . S2 and the volume control. We suggest that constructors start with mounting the power supply components, checking that the voltages and polarities are correct before going further. If you use a transformer with two secondaries, ensure they are connected the correct way round.

Calibration is a straightforward case of simply adjusting P1 (the clock frequency) until the pitch of the voice sounds human. Alternatively, you can have a 'donald duck' sound if you prefer.

To make life easier a loaded EPROM is available from Technomatic Ltd (see their advertisement).

One suggestion put forward for a suitable case is to construct a cube from perspex.

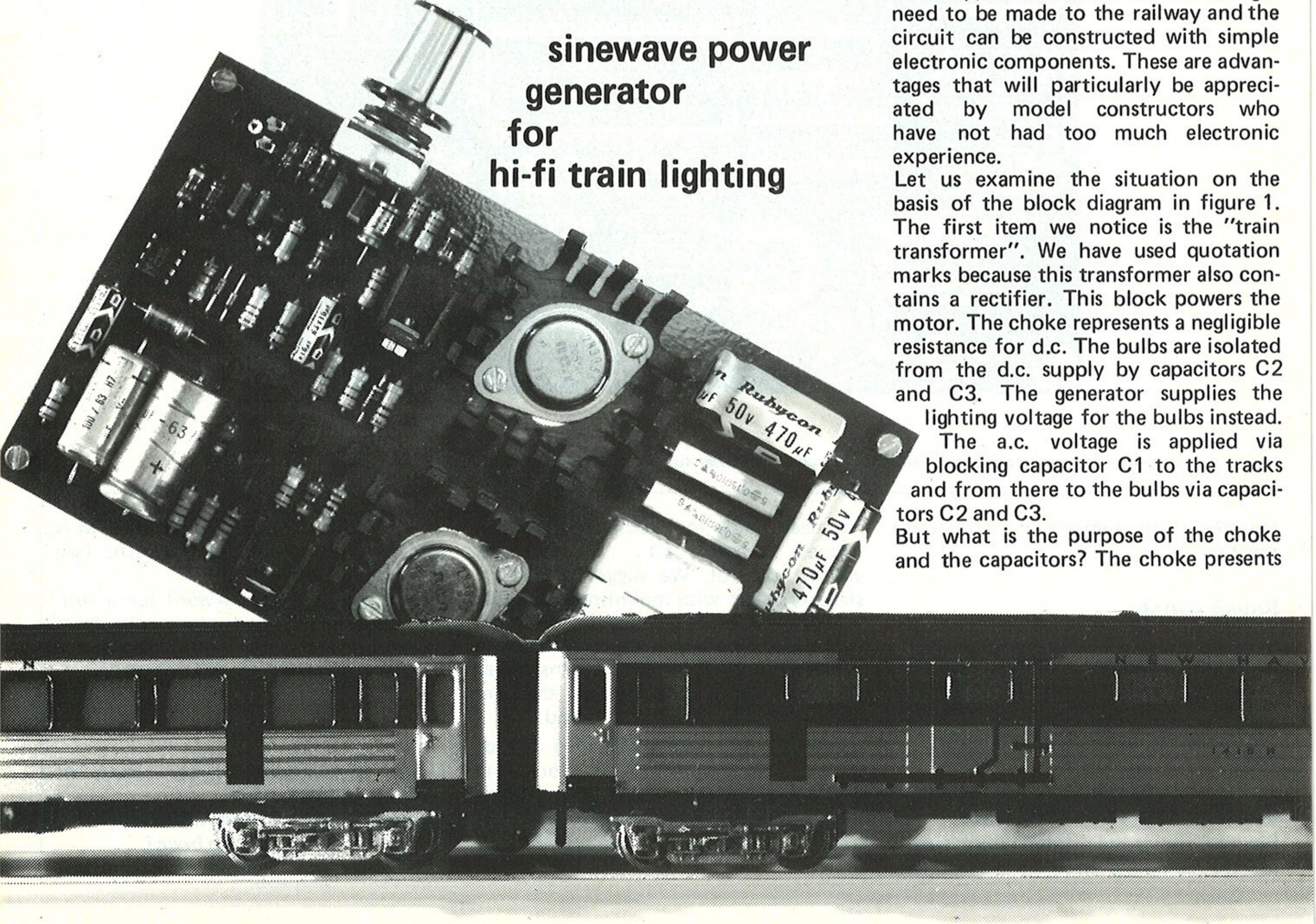
As the saying goes 'the die is cast'.

Useful back issues for the theory of speech synthesis.
September 1981 Talking chips.
December 1981 Talking board.
February 1982 Talking board interface.

model train lighting

"Murder on the Orient Express!" The train enters a tunnel. The lights go out. A blood-curdling scream is heard and the famous detective Hercule Poirot has another assignment. Things are not usually so dramatic amongst model train enthusiasts and one cannot normally look into the tunnel of a model railway. But when the train stops and the internal lighting goes off, it is not very realistic. What we need is a circuit that will keep the lights on, even when the train stops.

sinewave power generator for hi-fi train lighting



What is actually involved? Well, the lighting for the railway itself can be provided quite simply by means of a "lighting transformer". Stations, houses and signals then become part of a realistic environment, for the railway. However, the bulbs in the carriages are powered from the "train transformer" via the rails. So, there is no problem with lighting as long as the train is travelling. But when the train stops, the lights go out because power is no longer applied. If the locomotive supply voltage is not constant the bulbs flicker. What we need is a method of operating the train lighting independently of the locomotive supply voltage.

A look at various solutions

One could, for example, construct a multiple rail system which would carry both the locomotive supply voltage and the lighting supply voltage; that would surely be too expensive. An overhead line plus one of the two rails could also be used for the lighting supply voltage. This method is less complicated, but the overhead line is usually employed for independent operation with two trains. The same applies to any third rail in the system. It is also possible to use dry batteries but this method must be ruled out because of the cost. Rechargeable NiCd batteries cannot be employed on account of their price, shape and weight. Furthermore, that method would require a bridge rectifier.

Half-wave operation is worth considering. A sinewave can be divided into two half-waves. The motor is activated for the duration of one half-wave and the lighting for the duration of the other. This method can be applied quite simply using properly rated diodes. It is a purely electrical solution without any mechanical modifications. The disadvantage is that half-wave operation requires four times the power output for normal operation. Moreover, this method only works for one direction of travel although it is possible to operate two trains independently in this way.

Our solution

A sinewave power generator. Admittedly, it is not new but no changes need to be made to the railway and the circuit can be constructed with simple electronic components. These are advantages that will particularly be appreciated by model constructors who have not had too much electronic experience.

Let us examine the situation on the basis of the block diagram in figure 1. The first item we notice is the "train transformer". We have used quotation marks because this transformer also contains a rectifier. This block powers the motor. The choke represents a negligible resistance for d.c. The bulbs are isolated from the d.c. supply by capacitors C2 and C3. The generator supplies the lighting voltage for the bulbs instead. The a.c. voltage is applied via blocking capacitor C1 to the tracks and from there to the bulbs via capacitors C2 and C3.

But what is the purpose of the choke and the capacitors? The choke presents the a.c. voltage with a very high impedance so that the sinusoidal power is not lost in the low-impedance secondary side of the train transformer. Blocking capacitor C1 isolates the d.c. train voltage from the power generator. Only in this way is it possible to superimpose the a.c. voltage on the d.c. voltage for our purposes. One disadvantage should be pointed out, however. Although the motor represents a load for the a.c. voltage it is so small it can be discounted. Two questions that might be raised with respect to the power generator are: why a sinewave and why 20 kHz? Wouldn't a square-wave generator be much more efficient? The answer is yes, but the harmonics would cause severe interference to other equipment! We have chosen 20 kHz because the circuit and the locomotives start buzzing at lower frequencies and because this frequency allowed us to choose smaller values for the choke and capacitors. But we will go into this in more detail later.

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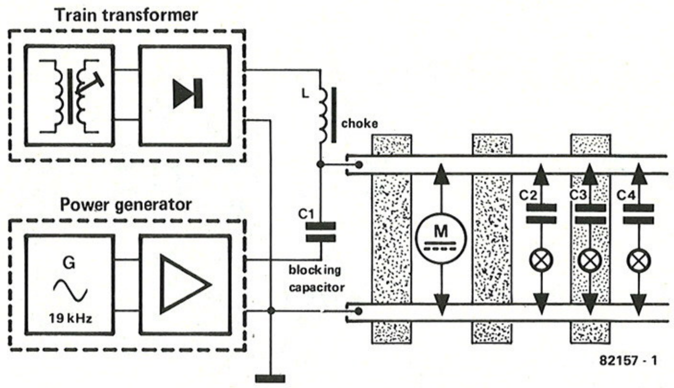


Figure 1. The a.c. output voltage of the power generator is applied to the tracks, superimposed on the a.c. voltage of the train transformer. The choke isolates the train transformer from the a.c. voltage and capacitor C1 isolates the power generator from the d.c. voltage. Capacitors C2, C3 etc. keep the d.c. voltage away from the bulb circuits. Apart from having to install the bulbs and capacitors in the carriages, no technical modification to the railway system is necessary.

The power generator

Before the system can be extended as shown in figure 1, we must first build the power generator and ensure that it is operating. First we shall have a look at the circuit.

Figure 2 mainly contains two functional parts: the sinewave generator using IC1 and the output stage consisting of T1 . . . T10. Choke L1 can also be seen, together with the power supply unit for the power generator with transformer, rectifier B1, and smoothing capacitor C14. A no-load d.c. voltage of 42 . . . 51 V is present at C14, depending on the transformer used.

The sinewave generator is configured as a Wien-bridge oscillator with IC1, D1, D2, C1, C2 forming a symmetrical power supply for the operational amplifier from the "asymmetric" operating voltage. This method also provides decoupling from the operating voltage of the output stage. R2, C3, C4, R5 are the generator components that determine the frequency. The oscillator frequency obtained purely by calculation is 19 kHz. The two germanium diodes provide coarse stabilisation of the output voltage. The gain (onset of oscillation) is adjusted with P1, and P2 is used to attenuate the amplitude of the generator (bulb brightness). The distortion factor of the sinewave oscillator is only 0.05%. It therefore emits practically no harmonics to cause distortion in the power generator.

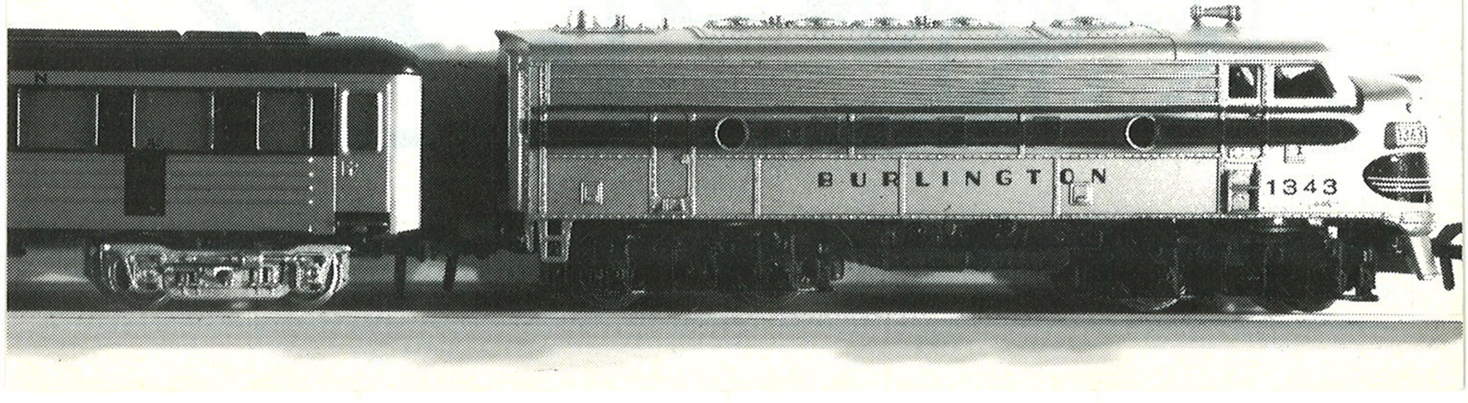
The next item is an old friend (as far as Elektor staff are concerned): EDWIN the output amplifier. This was first published way back in the seventies. In the meantime it has probably become the favourite and mostbuilt amplifier from the Elektor Laboratory. It is characterised by good reproducibility in construction, requires no alignment and the output transistors can now be procured at very low cost in most electronic component shops. The values of a few capacitors were reduced from those of the original circuit, because the amplifier is only needed to provide gain at 19 kHz. The output capacitor must be a bipolar type. Two polar electrolytic capacitors were connected back-to-back here. The output stage is shortcircuit-proof but not in continuous duty! We also thought that the finger-type heatsinks would be very practical for circuit constructors and they are quite adequate in this application. We shall discuss the assembly in more detail later.

Choosing the components

Before you pick up your soldering iron, here are a few useful comments concerning the components.

Choke L1: The choke must withstand a bulb current of about 2 A. With a total bulb power rating of 25 W maximum at 12 V the load current is 2 A. Suitable (mains) chokes must exhibit an inductance of 10 . . . 20 mH. The d.c. resistance at a frequency of 19 kHz is 1k2 . . . 2k4. The choke with its impedance of 3 . . . 6 ohms is practically a shortcircuit for mains frequency voltages. A mains choke from an old TV set is just as good as one of the new commercially available types. Coils from loudspeaker cross-over networks may also be employed if they meet the requirements.

Mains transformer: Using a transformer with a secondary voltage of 33 V, the output stage delivers about 25 W (at Urms = 12 V). This is where term hi-fi the scene. Hi-fi means "high fidelity" and here we are referring to realistic lighting in the train. The lighting voltage is adjusted so that the bulbs are operated at less than their rated voltages. In this way we achieve two things: the bulbs are not unrealistically bright (in keeping with our "hi-fi") and they last much longer than their rated service lives. For example, 14 V bulbs can be connected to the 12 Vrms output voltage or a 30 V transformer could be used to give an output voltage of 10 . . . 11 Vrms.



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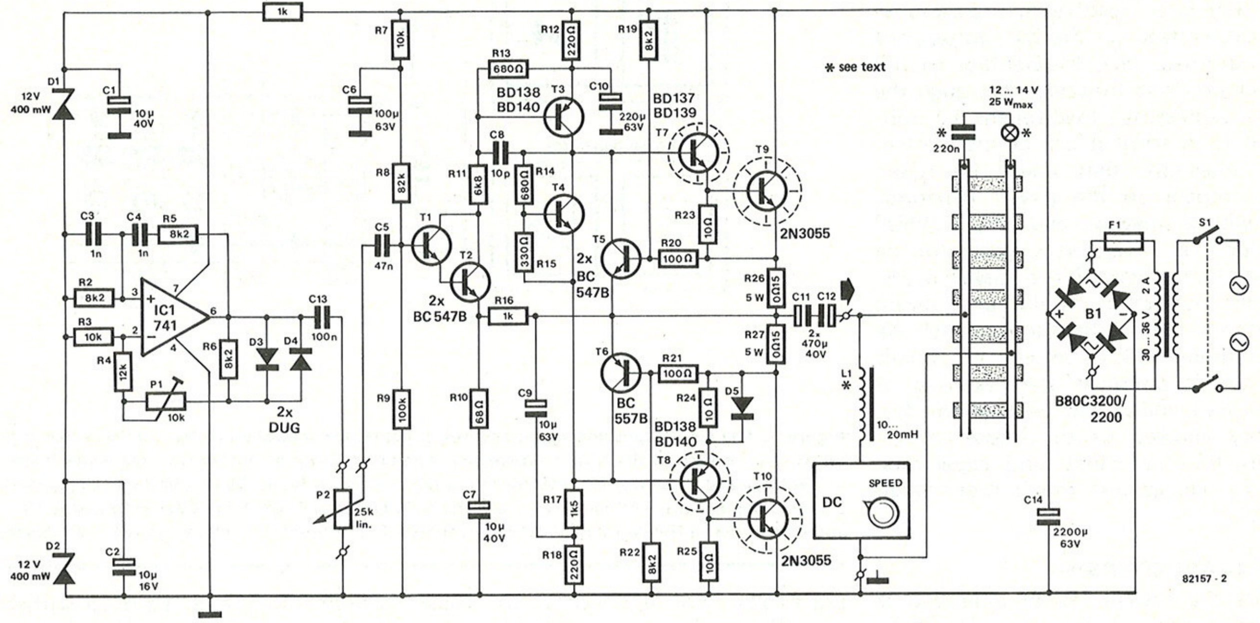


Figure 2. The circuit of the sinewave power generator consists of a Wien-bridge oscillator with IC1. Brightness of the train lighting is continuously variable with P2. The output capacitor must be a bipolar type because the rail voltage can be positive or negative (with respect to earth), depending on the direction of the travel.

3

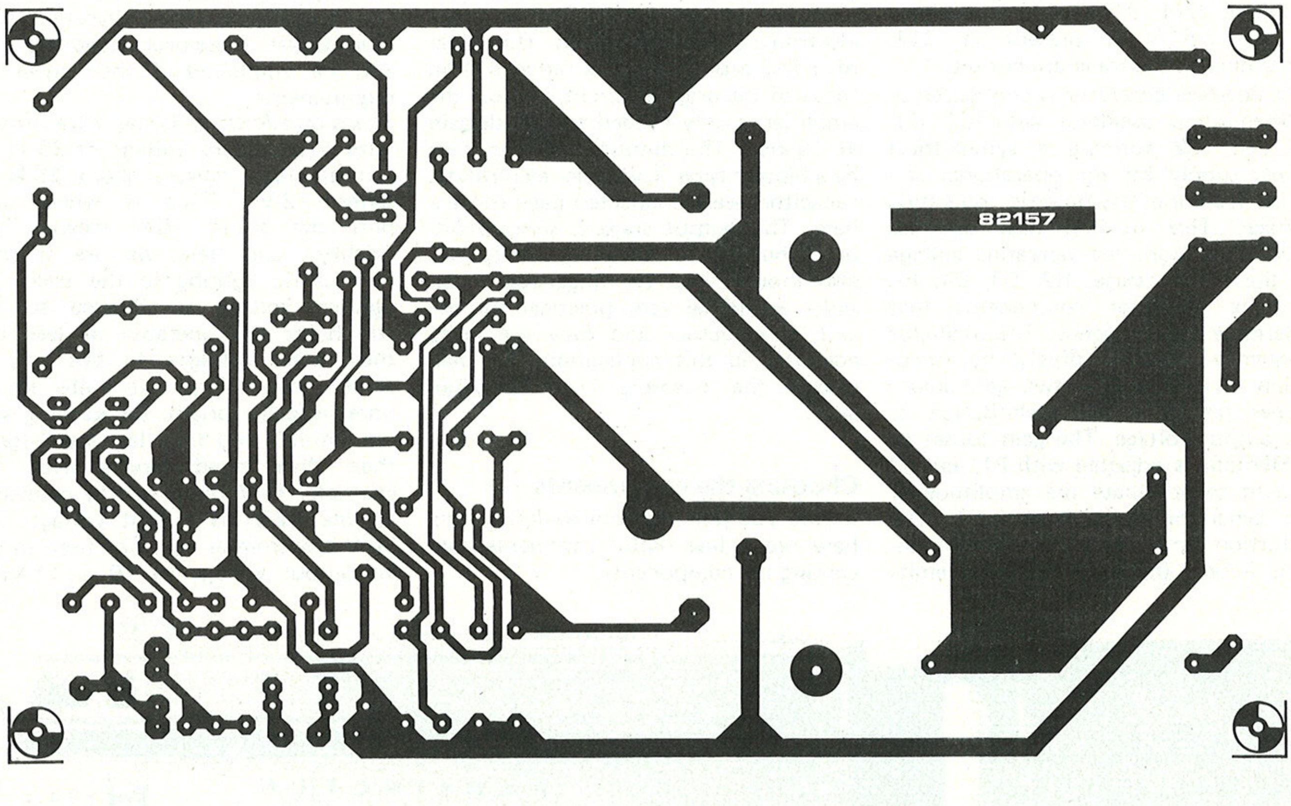


Figure 3. The printed circuit board for the power generator. All components are mounted on the board except for the mains transformer, fuse and mains switch. Since the output transistors are mounted on the printed circuit board with heatsinks (see text), the cover of the housing must allow sufficient ventilation.

In any case, the full output power of 25 W will never be required from the output stage. That would be sufficient to illuminate 25 carriages! The maximum output voltage will therefore be somewhat higher than indicated, on account of the lower load. Since the bulbs are operated at less than their rated voltage, their full power ratings are not reached either. This means that bulbs with a total power rating of more than 25 W can be connected.

Blocking capacitors: The capacitors in series with the bulbs are installed in the carriage together with the bulbs. A 220 nF capacitor is sufficient for a 12 V/50 mA bulb. If only one capacitor is connected in series with several bulbs of this type, its value must be increased proportionally. The exact voltage being dropped over a capacitor is not particularly critical, because the bulbs are being operated at less than their rated voltages. However, it is possible to arrange for "emergency lighting" in a sleeping car, for example, by selecting an appropriate value for the blocking capacitor. Those who would like to experiment can calculate the required series reactance according to the formula $X_C = \frac{1}{2 \cdot \pi \cdot f \cdot C}$. X_C should be at least 80% less than the bulb resistance (e.g. 240 Ω at 12 V/50 mA).

Parts list

Resistors:
R1,R16 = 1 k
R2,R5,R6,R19,R22 = 8k2
R3,R7 = 10 k
R4 = 12 k
R8 = 82 k
R9 = 100 k
R10 = 68 Ω
R11 = 6k8
R12,R18 = 220 Ω
R13,R14 = 680 Ω
R15 = 330 Ω
R17 = 1k5
R20,R21 = 100 Ω
R23 . . . R25 = 10 Ω
R26,R27 = 0,15 Ω/5 W
P1 = 10 k trimmer
P2 = 25 k lin. pot.

Capacitors:
C1,C7 = 10 μ/40 V
C2 = 10 μ/16 V
C3,C4 = 1 n
C5 = 47 n
C6 = 100 μ/63 V
C8 = 10 p
C9 = 10 μ/63 V
C10 = 220 μ/63 V
C11,C12 = 470 μ/40 V
C13 = 100 n
C14 = 2200 μ/63 V

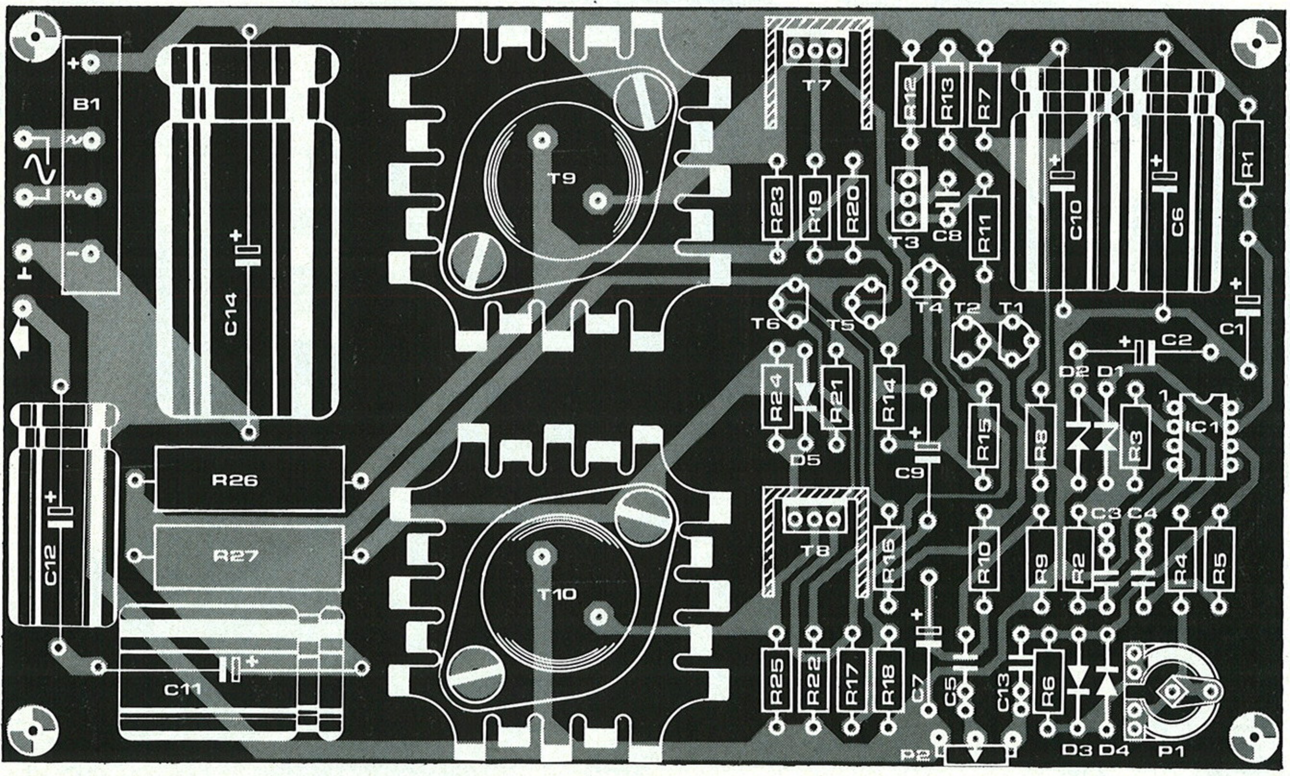
Semiconductors:
B1 = B80C3200/2200
D1,D2 = Z-Diode 12 V/0,4 W
D3,D4 = AA 119
D5 = 1N4001
T1,T2,T4,T5 = BC 547B
T3,T8 = BD 138 or BD 140
T6 = BC 557B
T7 = BD 137 or BD 139
T9,T10 = 2N3055
IC1 = 741

Miscellaneous:
L1 = (mains) choke 10 . . . 20 mH (see text)
Tr1 = mains transformer 30 . . . 36 V/2 A sec. (see text)
F1 = 2 A fuse, slow-blow with holder
S1 = double-pole mains switch

Construction and alignment

Construction of the sinewave power generator should present no problem using the ready made printed circuit board (figure 3).

T7 . . . T10 are fitted with heatsinks. In the case of T7 and T8 they are bracket-type heatsinks which are simply installed on the cooling surfaces of the transistors with M3 bolts. Do not forget the heat-conducting paste and ensure that there is no contact with any bare



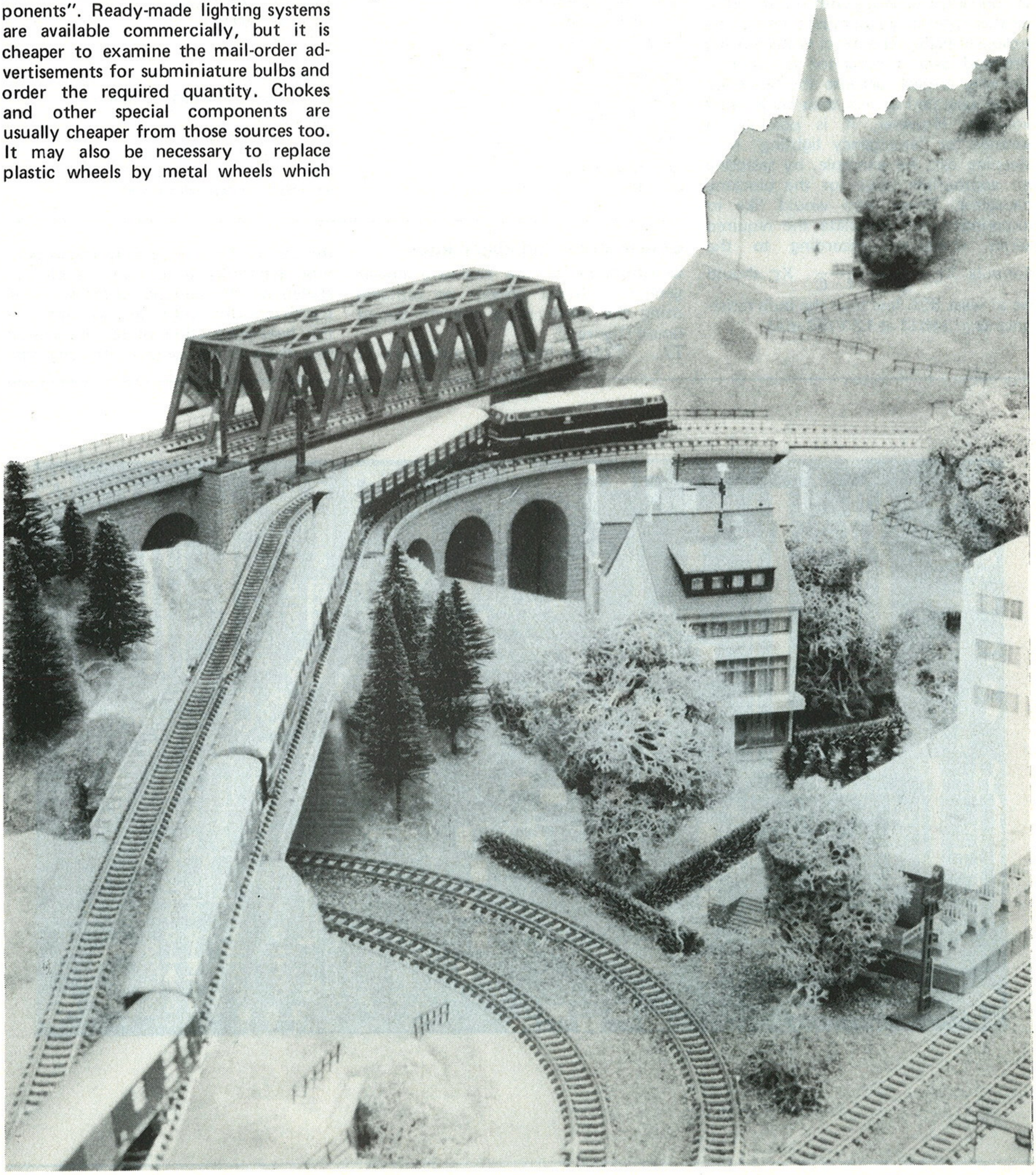
wires. T9 and T10 are fitted on the printed circuit board together with heatsinks. Sleeving should be slipped over their pins to prevent any short-circuits. The contact surfaces for the collectors are first tinned on the soldering side. The transistors and heatsinks are then bolted to the printed circuit board. Use washers to keep them firmly in place. Remember the heat-conducting paste here too! Finally, the insulated terminals are soldered to the tracks.

Once the components have been fitted to the printed circuit board, the system can be expanded as shown by figure 1. Please observe the comments in the section entitled "Choosing the components". Ready-made lighting systems are available commercially, but it is cheaper to examine the mail-order advertisements for subminiature bulbs and order the required quantity. Chokes and other special components are usually cheaper from those sources too. It may also be necessary to replace plastic wheels by metal wheels which are mounted on the axles in an insulated manner. Your local model shop can advise you on this.

Once the circuit is completed in accordance with figures 1 and 2, switch S1 can be actuated for the first time with the hope that there will be no smell or smoke! Set P2 to maximum output and adjust P1 so that the bulbs are lit. The output voltage can be measured with a multimeter set to the a.c. range. It must not exceed 12 V. The setting can also be made by eye: rotate P1 so that the bulbs light up at the desired brightness. Those model constructors who own an oscilloscope can make "professional" adjustments. With the load connected, P1 is set to a point just before the "clipping" of the displayed sinewave, (with no limiting of the amplifier). Brightness of the bulbs can now be adjusted as desired with P2.

Another important comment: In this form the circuit is only suitable for d.c.-driven trains. A combination with pulse-controlled systems is possible.

If the lights should go out in the tunnel and a blood-curdling scream is heard: call Hercule Poirot! ◼



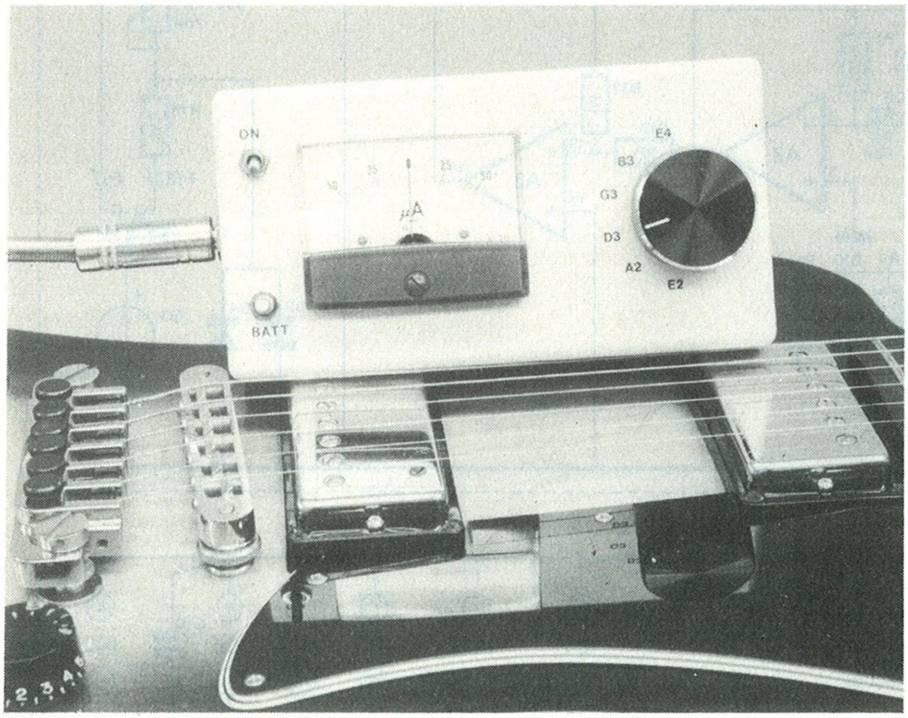
guitar tuner

tuning by eye . . . .

The problem with guitar tuning is very rarely the guitar itself. It is usually the surrounding noise and confusion that seems to reach a peak just at the wrong moment. Many guitarists have realised that these problems can be overcome with a visual tuning aid. The circuit described here is purely electronic and, most important, it is very accurate.

Tuning a guitar by ear is not too difficult provided you can hear what you are doing. In a crowded room or on stage, with everybody else running about with all sorts of equipment, tuning 'by eye' is definitely to be preferred. It is not surprising therefore, that electronic guitar tuners are quite popular with professionals.

Amateurs (and novices) would also like to have one of these units, but they soon discover that the 'real thing' tends to be expensive. A home-construction design would be ideal, provided it works properly, and is easy to use. In other words they are looking for the circuit described here!



Most commercial units use a moving coil meter to indicate the tuning accuracy. When the string is too 'low' or too 'high', the needle moves to the left or right respectively. The string is in tune when the needle is centred. This is a good system, so our circuit operates the same way. The scale is calibrated from –20Hz . . . +20Hz. Furthermore the design allows the tone of the string plucked to be retained, so that the indication changes slowly and progressively. This means that plucking each string once is often sufficient to tune it. The meter shows exactly what is going on while you turn the tuning key.

Finally the height of sophistication: the circuit is suitable for both electric and acoustic instruments!

The circuit

The principle behind a tuning aid is relatively simple. The guitar supplies a tone, which is compared with a reference. For obvious reasons, the reference frequency oscillator must be accurate and stable. The circuit described here uses a crystal oscillator and a top octave synthesiser, to provide reference frequencies that are accurate to within 0.07%.

Simple frequency comparison would seem to be the next step, but there is one further problem. The tone of each guitar string is rich and full, due to the large number of harmonics produced. Before any comparison can be made, these 'confusing' frequencies must be filtered out.

The reference tone

Figure 1 shows the circuit diagram of the complete guitar tuner. The crystal oscillator uses an easily available and cheap 4MHz TV type crystal. C1 is used to trim the crystal frequency. The signal from the oscillator is buffered (N2) and fed to the input of a flip-flop, FF1. This acts as a frequency divider, so that the output to IC3 is at 2MHz (or 2000240Hz to be exact).

The top octave synthesiser, IC3, is an ion-implanted P-channel MOS synchronous frequency divider, TOS for short. Each output frequency is related to the others by a multiple of $\sqrt[12]{2}$, providing a full octave plus one note on the equal tempered scale. This is illustrated in figure 2. The S50240 was used in the prototype, in preference to the MK50240 because of the difference in current consumption (14mA as opposed to 24mA). Even so, the total consumption of the circuit with the S50240 is about 20mA from each of the 9V batteries, and this is the reason for including a battery check facility (S3).

Going back to the circuit, the output of IC3 is passed to a seven stage binary counter IC4. Each stage is in effect a flip-flop. In principle therefor, all the tones of 8 full octaves (1 . . . 8) can be produced (see figure 3). For practical reasons, unfortunately, the division ratios in the top octave synthesiser cannot be more than good approximations, and so the actual frequencies produced are a maximum of ± 0.07% out.

The frequencies within the darker rectangles in figure 3 are the actual tones for each string of a normally strung standard 6 string guitar: E2

1

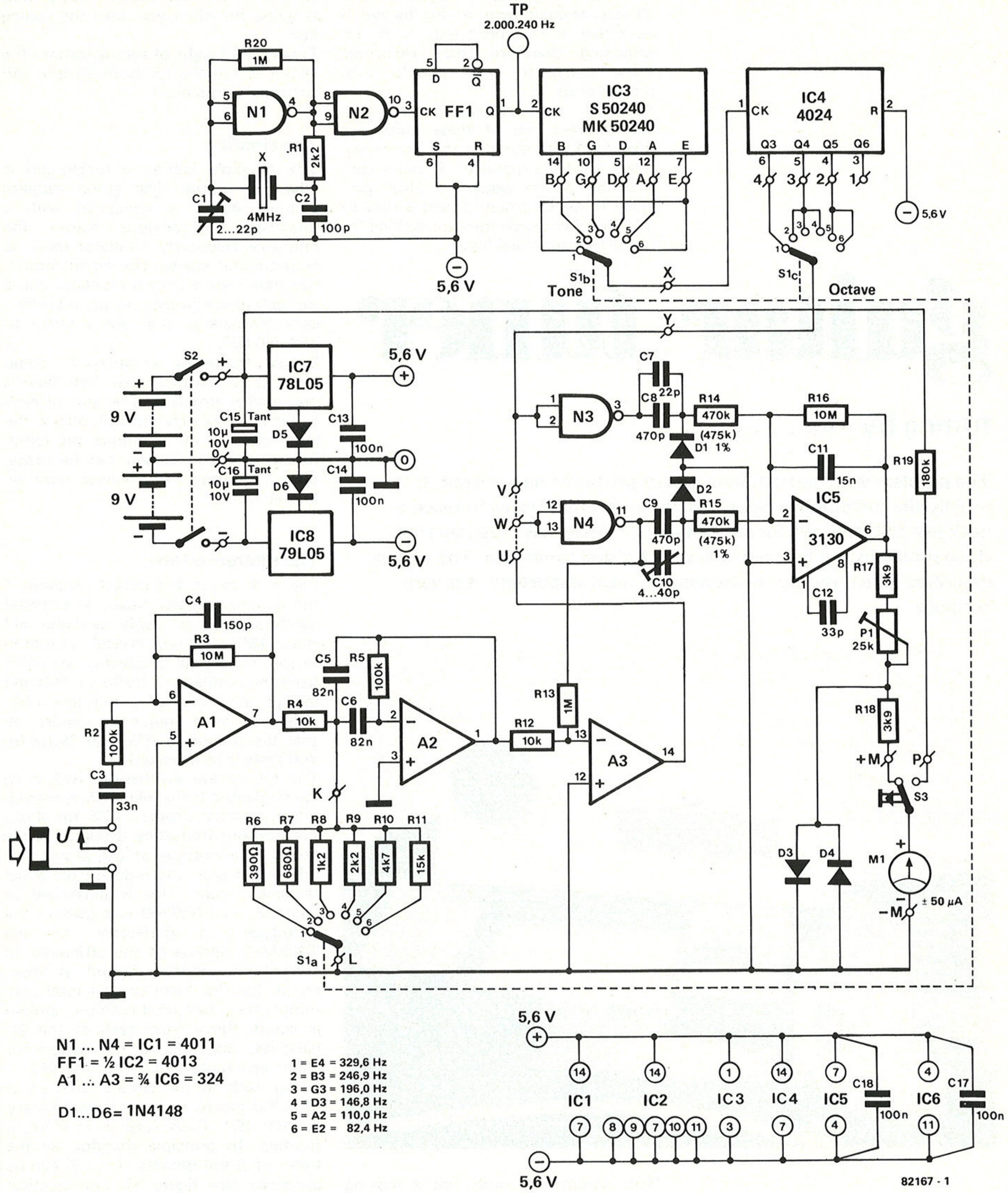


Figure 1. The circuit diagram of the complete tuner. For use with an acoustic guitar R2 = 10 K and C3 = 220 n.

or bottom E (sixth string), A2, D3, G3, B3, and E4 or top E (first string). S1b selects one of the five desired notes in the top octave and passes this signal to IC4. The outputs of this IC cover a total of three octaves, to enable the tuner to be effective for a six string guitar. Output Q6 (octave 1) of IC4 is not connected, but it can be used for tuning bass guitars. With S1b and S1c connected as shown, the desired tones are produced in their correct octaves.

2

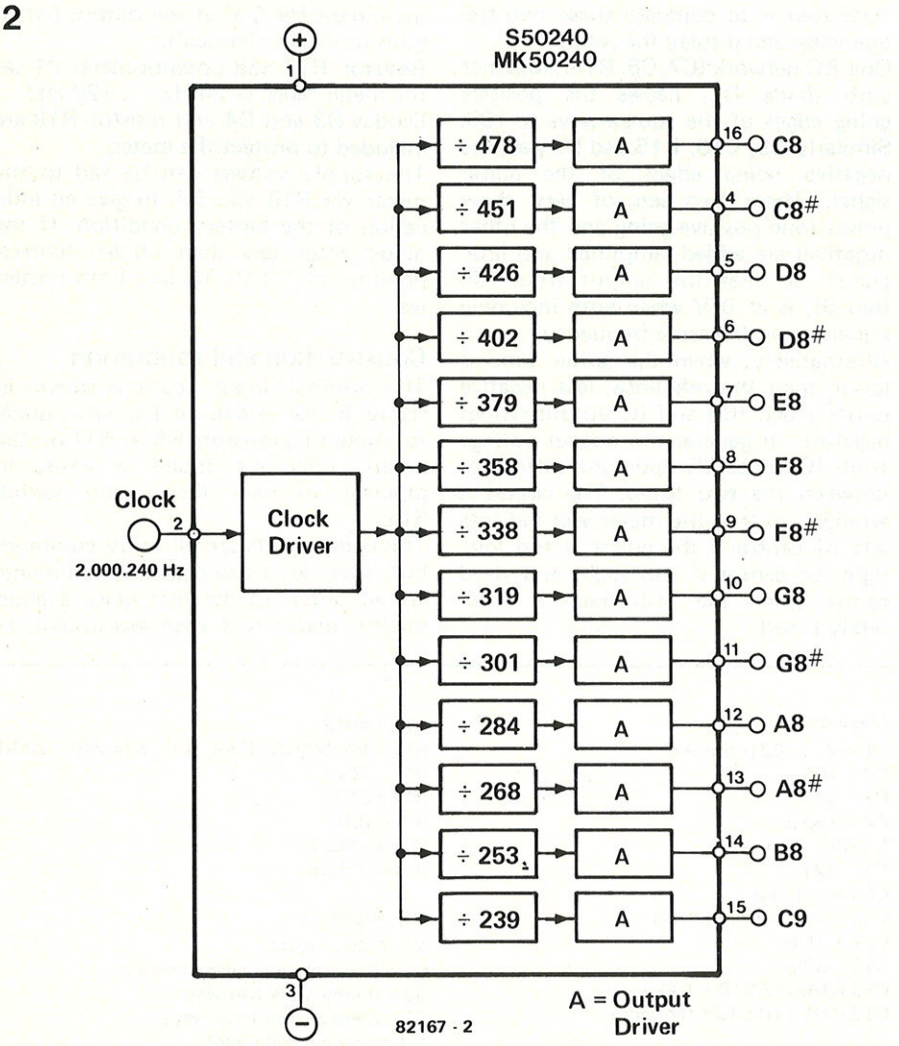


Figure 2. The block diagram of the top octave synthesiser, used to generate the basic reference tones.

The input stage

As already mentioned, the harmonics produced by the guitar can pose a major problem. The best solution is to provide adequate filtering at the input. At the same time it is useful to set a fairly high gain in the input stage, so that the guitar signal can be measured well into the decay time. This makes tuning that much simpler, since you do not have to pluck the string so often. In the actual circuit, opamp A1 is set to a gain of 100X. C3 and C4 have been included in the network around A1 as a general band-pass filter, to get rid of some of the 'dirt' in the guitar signal. The input impedance is 100 kΩ, which should cater for nearly every guitar.

Quite a narrow band-pass filter is constructed around A2. The band-width is only 40 Hz, effectively eliminating the harmonics and passing the fundamental only. The basic principle is shown in figure 4. The centre frequency is determined by R6 to R11, as selected by S1a. It should be noted that the resistors correspond to R3 in figure 4, so they have no effect on the gain or bandwidth. As a matter of interest the gain of the network is about 5X. Note that if other tones are selected (for tuning bass guitars), the values of R6 . . . . R11 must be modified accordingly!

A3 and N4 act as a schmitt-trigger, converting the output signal from A2 into a square wave. The hysteresis is 110 mV.

The comparison

We now have a reference frequency at the output of N3 and the guitar fre-

3

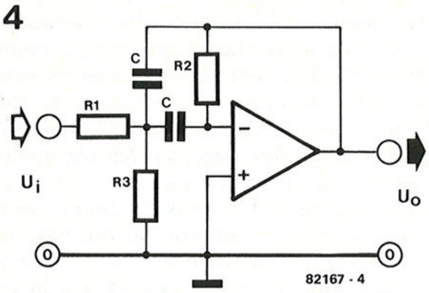
tone and frequency for musical instruments

tone	octave								
	0	1	2	3	4	5	6	7	8
C	16.3516	32.7032	65.4064	130.813	261.626	523.251	1046.50	2093.00	4186.01
C#	17.3239	34.6478	69.2957	138.591	277.183	554.365	1108.73	2217.46	4434.92
D	18.3540	36.7081	73.4162	146.832	293.665	587.330	1174.66	2349.32	4698.64
D#	19 4454	38.8909	77.7817	155.563	311.127	622.254	1244.51	2489.02	4978.03
E	20,6017	41.2034	82.4069	164.814	329.628	659.255	1318.51	2637.02	5274.04
F	21,8268	43.6536	87.3071	174.614	349.228	698.456	1396.91	2793.83	5587.65
F#	23.1247	46.2493	92.4986	184.997	369.994	739.989	1479.98	2959.96	5919.91
G	24.4997	48.9994	97.9989	195.998	391.995	783.991	1567.98	3135.96	6271.93
G#	25.9565	51,9131	103.826	207.652	415.305	830.609	1661.22	3322.44	6644.88
A	27,5000	55.0000	110.000	220.000	440.000	880.000	1760.00	3520.00	7040.00
A#	29.1352	58.2705	116.541	233.082	466.164	932.328	1864.66	3729.31	7458.62
B	30.8677	61.7354	123.471	246.942	493.883	987.767	1975.53	3951.07	7902.13

frequency in Hz

Figure 3. The frequencies of the tones in each octave. The 'blocked' frequencies are the ones used for the guitar tuner.

4



centre frequency : $f_0 = \frac{1}{2\pi C} \sqrt{\frac{R1 + R3}{R1\,R2\,R3}}$

gain at f_0: $-A_0 = \frac{R2}{2R1}$

Q-factor: $Q = \pi\, R2\, C\, f_0$

bandwidth: $B = \frac{1}{\pi\, R2\, C}$

Figure 4. This second order filter is used in the circuit to eliminate the harmonics produced by a guitar string.

quency coming from N4. The next and final step is to compare these two frequencies, and display the result.

One RC network (C7, C8, R14), together with diode D1, passes the positive going edges of the square-wave to IC5. Similarly C9, C10, R15 and D2 pass the negative going edges of the guitar signal. These two sets of very short pulses (one positive-going and the other negative) are added, amplified and integrated, so that the output from IC5 (pin 6), is at 0 V when both incoming signals are at the same frequency.

Alternatively, when the guitar tone is lower than the reference, less negative pulses reach IC5 and its output swings negative. In general the output voltage from IC5 depends upon the difference between the two tones. The circuit is arranged so that the meter will indicate left of centre if the guitar is too low, right of centre if too high, and dead centre when the instrument is accurately tuned.

The trimmer C10, is used to calibrate the circuit for 0 V at the output (when both tones are identical).

Resistor R17 and potentiometer P1 set the meter range (−20 Hz . . . +20 Hz).

Diodes D3 and D4 and resistor R18 are included to protect the meter.

The supply voltage can be fed to the meter via R19 and S3, to give an indication of the battery condition. If the meter reads less than 40 µA (corresponding to 7.2 V), replace both batteries.

Construction and calibration

The printed circuit board is shown in figure 5. No provision has been made for mounting resistors R6 to R11 on the board, since we found it easier in practice to wire these onto switch S1a.

The components are all fairly common, but, even so, a few practical comments are in order. In the first place a good quality meter is a wise investment, as

Parts List

Resistors (1/8 W):
R1,R9 = 2k2
R2,R5 = 100 k
R3,R16 = 10 M
R4,R12 = 10 k
R6 = 390 Ω
R7 = 680 Ω
R8 = 1k2
R10 = 4k7
R11 = 15 k
R13,R20 = 1 M
R14,R15 = 470 k (475 k) 1% precision
R17,R18 = 3k9
R19 = 180 k
P1 = 25 k preset

Capacitors:
C1 = 2 . . . 22 p trimmer
C2 = 100 p
C3 = 33 n
C4 = 150 p
C5,C6 = 82 n
C7 = 22 p
C8,C9 = 470 p
C10 = 4 . . . 40 p trimmer
C11 = 15 n
C12 = 33 p
C13,C14,C17,C18 = 100 n
C15,C16 = 10µ/10V tantalum

Semiconductors:
D1 . . . . D6 = 1N4148
IC1 = 4011
IC2 = 4013
IC3 = MK 50240 (Mostek), S 50240 (AMI)
IC4 = 4024
IC5 = 3130
IC6 = 324
IC7 = 78L05
IC8 = 79L05

Miscellaneous:
X = 4MHz crystal
S1 = 6 way double decked wafer
S2 = double pole two way
S3 = press-button (two way)
M1 = moving coil meter
(−50µA . . . 0 . . . +50µA)
2 battery terminals
1 standard jack socket (6.3 mm)

5

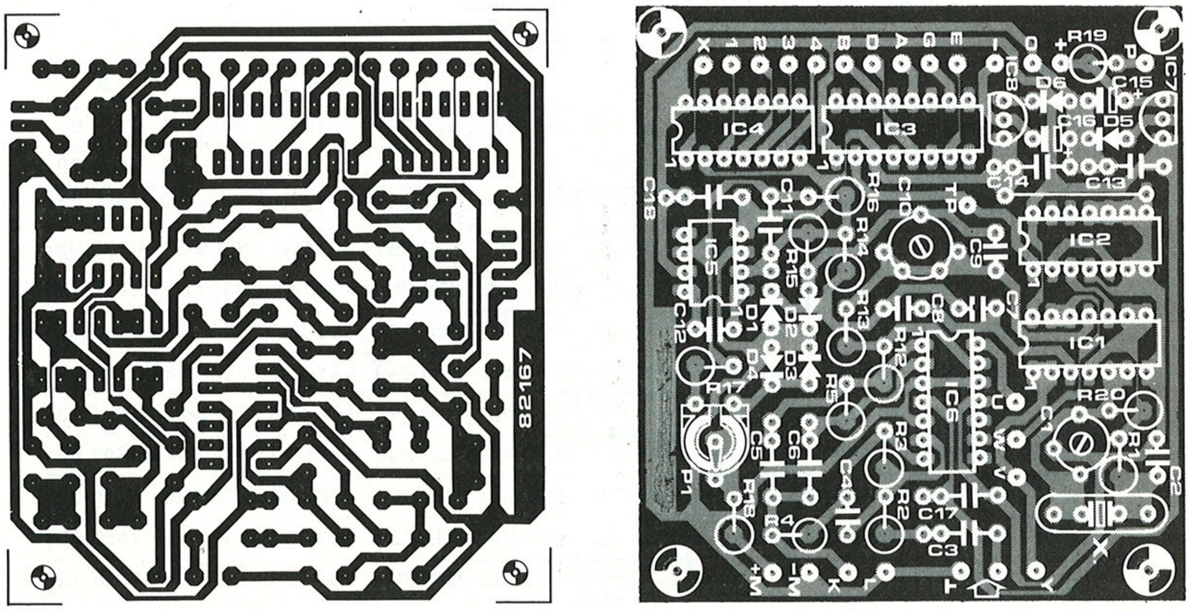
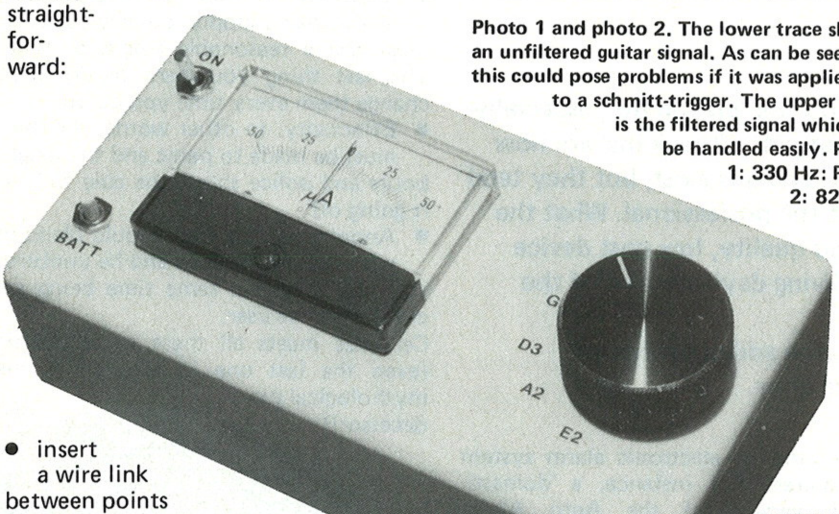


Figure 5. The printed circuit board for the guitar tuner.

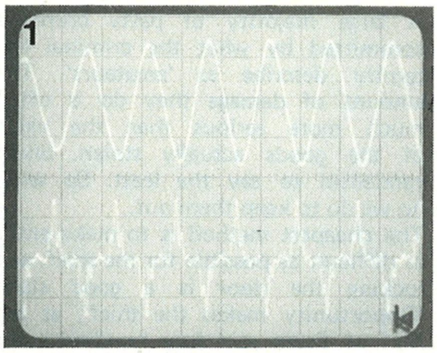
some of the cheaper variety are not sufficiently accurate. Then although the prototype used a double decked wafer switch for S1a . . . S1c, it is also possible to use one of the new multi-position slide switches that are available. The size of the case depends on the components used for the meter and switches, but we found a plastic box (Vero) size 15 x 8 x 5 cms was just right for the items we used (see photo). Bear in mind that the meter should be in a vertical position (not laying down), otherwise the accuracy is impaired. The case should be reasonably stable, so that it is not easily pulled over and onto the floor by the weight of the guitar lead. For the same reason, make sure that the case is robust!

There is nothing critical about the mounting of the components onto the printed circuit board, only that care should be taken in handling the ICs. Note that the resistors are mounted vertically.

The calibration of the circuit is equally straightforward:



- insert a wire link between points V and W, as shown in the circuit diagram in figure 1, and set P1 toits mid position.
- beg, borrow, or steal a high quality frequency counter — a model with 7 digit accuracy. Do we hear panic in the ranks? Fear not, dear majority— just skip the next sentence. If one is lucky and has a counter, simply connect it to point TP (the output of FF1) and adjust C1 for a reading of 2000240 Hz. If no frequency counter is available, just set C1 to its mid position. The frequency will never be more than 0.03% out, a mere trifle which can be discounted.
- Switch S1 to E4 and adjust trimmer C10 so that the meter is zeroed.
- remove link W-V and insert link W-U (the final situation).
- plug in a guitar and tune in E4: the first string open. Make sure the needle of the meter is exactly at 0 (string perfectly tuned) before going on any further.
- once open E (first string) is tuned, play the note F4 (349 Hz), which is first fret, first string. This is 20 Hz above and can therefore be used to calibrate the scale of the meter. Adjust P1 so that the meter reads +50 μA. This calibrates the meter to ± 20 Hz.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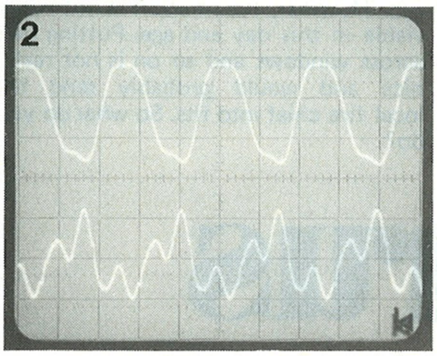
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Photo 1 and photo 2. The lower trace shows an unfiltered guitar signal. As can be seen, this could pose problems if it was applied to a schmitt-trigger. The upper trace is the filtered signal which can be handled easily. Photo 1: 330 Hz: Photo 2: 82 Hz

Practice

The tuner was tested 'on stage', where it performed perfectly (which is more than could be said for the musicians who tried it!).

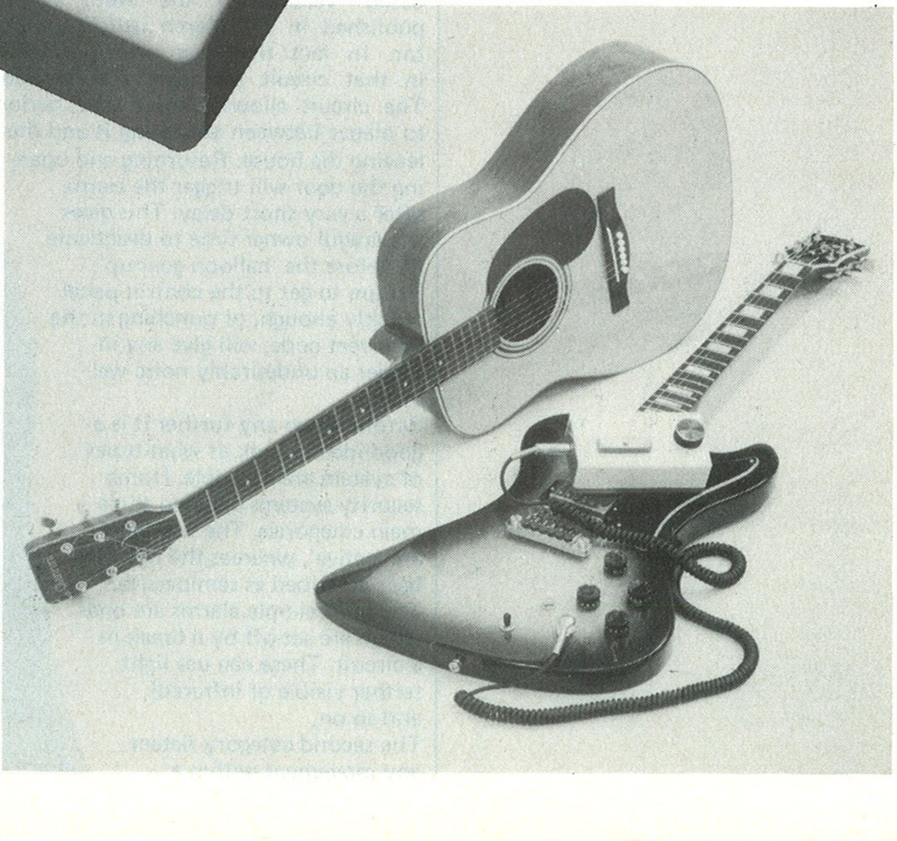
Its ability to display tones either one semitone above or below standard tuning was also found useful, especially for some fingerpicking techniques.

It had the same no-nonsense operation as the expensive commercial models.

The tuner also works very well with acoustic guitars. A good quality condensor microphone can be plugged into the standard jack socket of the tuner. However it is better to provide a second input, with R2 replaced by a 10 k resistor and C3 increased to 220 nF. This is because the microphone signal is not as high as that of the guitar and therefore the gain of A1 has to be increased to 1000 X. These modified values can also be selected by means of a small changeover switch at the input.

Final note

Constructors not wishing to use a battery supply can utilise the power supply of the Elektor Artist guitar pre-amp, published in our May 1982 issue. The positive rail can be taken from the positive side of C67 (refer to the circuit diagram of the Artist), the 0 from the negative side of C67, and the negative rail from the negative side of C68. This gives a supply of ± 8 V, which is ideal for our purpose. S3 and R19 will not be required in this case. Have a good tune up!



cerberus

electronic watchdog

We live in violent times. The crime rate is on the 'up and up', especially burglaries. More to the point is the fact that petty 'break-ins' are now almost common place. Sophisticated alarm systems exist, but they tend to be expensive and are meant to keep out the professional. What the average householder needs is a simple, good quality, low cost device which detects 'entry' and then scares the living daylights out of the intruder.

Hence Cerberus . . . . ! A circuit with the added facility of 'barking' every time someone arrives at the door.

A large majority of petty crime is committed by what the criminal fraternity describe as 'amateurs'. The amount of damage they do is often much more serious than the value of the goods actually stolen. Sheer vandalism to say the least. So what do we do to keep them out.

The cheapest method is to make entry as difficult as possible for the thief, and locking the door is a good start. 'Opportunity makes the thief', as the Earl of Essex said four hundred years ago. However, his solution is not really viable in this day and age. Putting bars across windows and so on is not really nice and would probably send the local fire chief into fits. So what do you do?

Some kind of electronic alarm system is required. For instance, a 'domesticated' version of the Auto Alarm published in the March issue of Elektor. In fact the basic principles used in that circuit are ideal for the job. The circuit allows a short time period to elapse between activating it and then leaving the house. Returning and opening the door will trigger the alarm, after a very short delay. This gives the lawful owner time to deactivate it, before the 'balloon goes up'. Failure to get to the control panel quickly enough, or punching in the incorrect code, will give any intruder an undesirably noise welcome.

Before we go any further it is a good idea to look at what types of system are available. Home security systems come in three main categories. The first two are 'active', whereas the third is best described as semipassive.

The most simple alarms are ones which are set-off by a break in a circuit. These can use light (either visible or infrared), and so on.

The second category detect any movement within a given area. These are very complex affairs, often based on some kind of radar. In general they are too sensitive and expensive for normal home use.

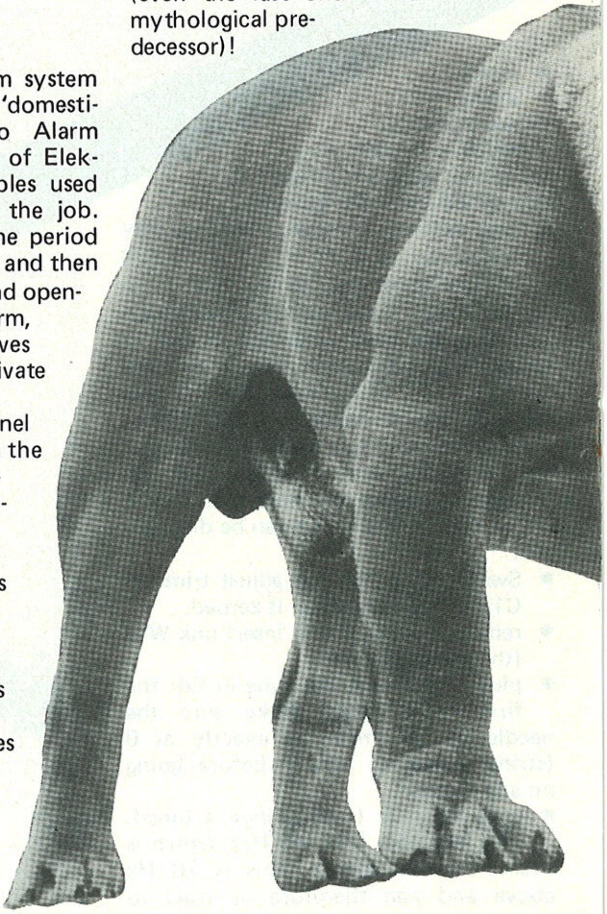
Finally, semi-passive systems are not really alarms in the true sense. They simulate the presence of an accupant by turning lights on and off, opening and closing curtains in a true to life sequence. Hopefully they scare off the amateurs.

The quality of alarms

How sophisticated should a domestic alarm be? This is not an easy question to answer. The better the quality, then normally the higher the price. If you want value for money the points to consider can be itemised as follows.

- Reliability. It must always work at the right time, and never 'for no apparent reason'. Some of the expensive models have been known to be triggered by a fly hitting the window.
- Simplicity. This applies both to installation and operation.
- Economy. It must be independent of the mains supply, but the batteries must last a reasonable length of time. The last thing you want to do is to change them every time you go out.
- Effectivity. In other words, the thief must be made to panic and the neighbours and police should be able to hear it going off.
- Anonimity. The unit should blend in with the decorations and be unobtrusive, while at the same time being accessible to the user.

Cerberus meets all these requirements (even the last one in contrast to his mythological predecessor)!



Working principles

The alarm is switched on by means of a pushbutton (S2). When it is armed, operating a further pressbutton (S3) has the effect of temporarily disabling it for a period of 10 . . . 15 seconds. This allows you to leave the house without waking the dead. Once the door is closed behind you the alarm is reactivated.

Opening the door triggers a second timer, again giving a delay of 10 to 15 seconds. This is sufficient for you to punch in the correct code (using S4 . . . S13) to deactivate the alarm. If you do not get to the box in time or enter the wrong code, the alarm will sound. Another function of the system is to announce the arrival of visitors. In this mode it gives a short bleep whenever the door is opened, in much the same way as the bell that rings when someone enters your local store.

The circuit

Figure 1 shows the circuit in block diagram form. The control panel of the system consists of a keyboard with 12 keys (S3 . . . S14). The only other controls are the pushbutton S2 and the function selector S1 (Alarm or visitor arrivals).

The heart of the circuit is the 'logic and control' section, which consists of a single IC.

The starter is used to arm the system; the delay circuit allows the user to leave and enter without triggering. A detector is required to establish when the door is opened and, finally, an oscillator produces the audio signal that drives the buzzer.

1

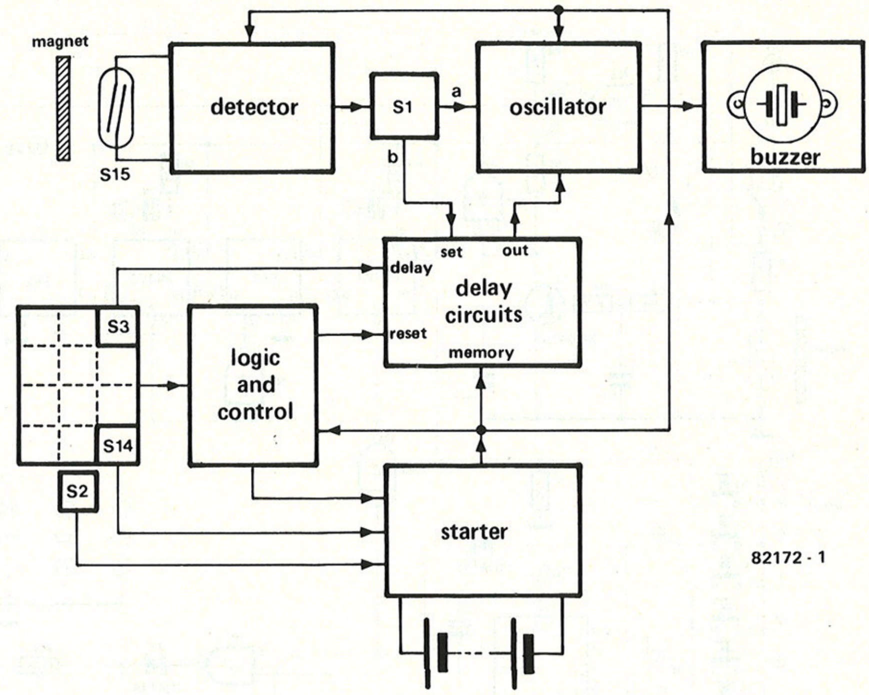


Figure 1. The block diagram shows the principal sections of the alarm system.

Figure 2 shows the circuit diagram of the complete alarm. As a result of depressing S2, T4 conducts. This in turn provides base drive for T3: the circuit latches 'on'. Initially the input of N2 is pulled high, via C8. This caters for power-up reset, after all we do not want the alarm to sound instantly!

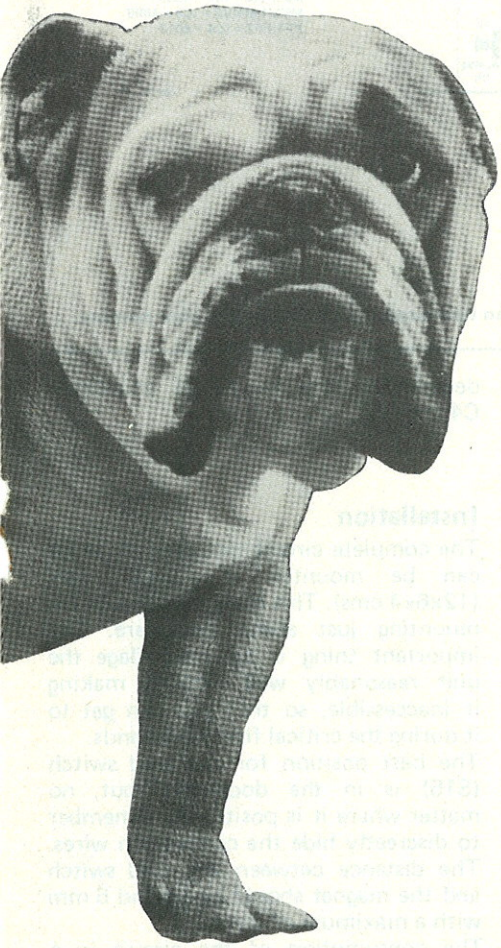
Now let us assume that we want to pop down to the local for a quick pint. Operating S3 sends a trigger pulse to the multivibrator MMV1 (pin 4), initiating the delay cycle. The delay time is defined by the RC network connected to pins 1 and 2. With the values shown in the circuit diagram, the total delay is 12 seconds. Provided the door is opened during this period, the circuit will remain inactive indefinitely, only 'arming' when the door is closed.

Once the circuit is armed, the door causes the reed relay S15 to close. T1 now conducts, sending a pulse to the clock input of the flip-flop FF1 (pin 11). Its Q output now goes 'high' (logic 1), and as a result the monostable multivibrator MMV2 is triggered by the pulse arriving at pin 12. This starts a new delay period determined by the RC network connected to pins 14 and 15. During this time the lawful owner can get to the keyboard and punch in the correct code to disarm the alarm. In the example given in the circuit diagram, the keyboard is wired to give the secret code 3058. Once the correct code is entered, the command circuit IC5 sends a reset pulse to the various parts of the circuit via gates N2 and N3.

Now suppose an intruder gains access to the keyboard, or the householder forgets the code . . . for some reason or other, the correct code is not entered within the delay period. The clock input of FF2 receives a trigger pulse; output Q of FF2 goes high; the oscillator built around N6 . . . N8 is enabled and the alarm sounds.

In the normal course of events it is unlikely that you will forget the code. However, you must bear in mind that you have 10 seconds from the moment you depress the first key, to enter the complete code. If desired this can be followed immediately by key S14 which deactivates the circuit. In that case both inputs of the NAND N4 become logic 1, its output therefore is logic 0, so T4 ceases to conduct. The circuit will remain dormant until S2 is again depressed.

So far we have assumed that S1 is in position 'b' (alarm).



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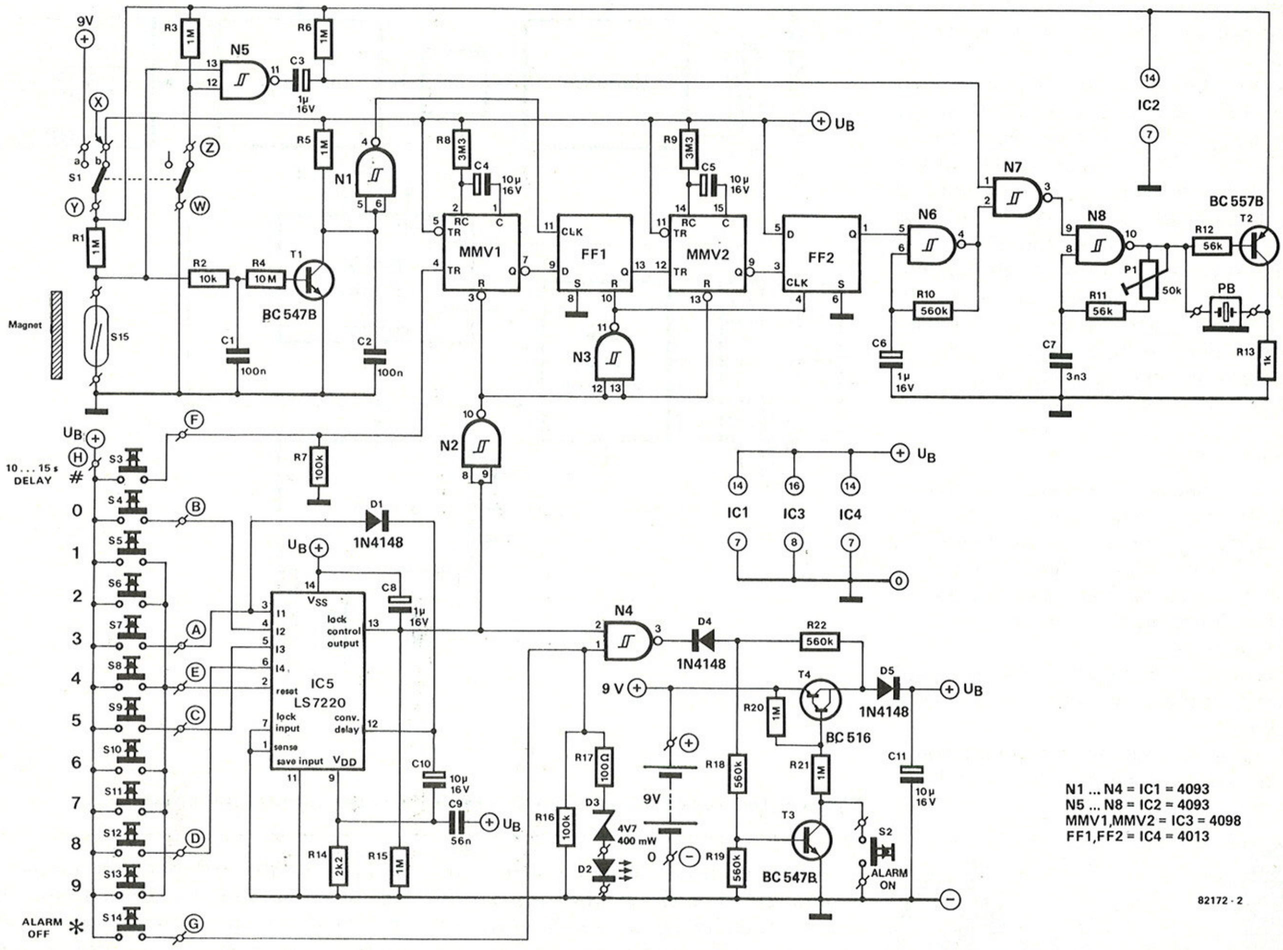


Figure 2. The complete circuit. As drawn here, the code for deactivating the alarm is 3058; this can be changed to any other four-digit number.

- Switching over to position 'a' puts the circuit in 'doorman' mode (arrival announcer). Every time the door is opened the alarm will sound for one second. This will happen irrespective of whether the alarm is activated or not (S2 depressed). With S1 in position 'a' and an activated alarm, both functions are combined: first the buzzer will sound for one second and then 12 seconds later, the actual alarm signal will be emitted.

S14 has two purposes. The first, already described is to deactivate the system (after entering the code). The second is a system check. When S14 is operated to shut down the alarm, LED D2 should light briefly to indicate that the battery is still good. If nothing happens press S2 to make sure the alarm is on, wait a few seconds and then try S14 again. Still nothing? Then what we have is a dead battery or broken LED.

Construction

The printed circuit board is shown in figure 3. Any type of keyboard will do, as long as it is possible for all the keys to be connected to a common rail (see figure 2). For this reason a so called matrix keyboard is unsuitable. The code given by the connections shown in figure 2 is merely a guide line. Any four digit code can be programmed by connecting the appropriate keys to the I1 . . . I4 inputs of IC5. Remember to connect all the other keys to the reset pin (E).

Potentiometer P1 is used to set the frequency of the buzzer tone, to obtain maximum output.

Should you wish to extend the time allowed for entering the code and depressing S14 (to deactivate the alarm), then this can easily be achieved by increasing the value of C10. The delay times of MMV1 and MMV2 depend on the values of capacitors C4 and C5.

Installation

The complete circuit including batteries can be mounted in a small box (12x6x4 cms). This makes it suitable for mounting just about anywhere. The important thing is to camouflage the unit reasonably well without making it inaccessible, so that you can get to it during the critical first 10 seconds.

The best position for the reed switch (S15) is in the doorjamb, but, no matter where it is positioned remember to discreetly hide the connection wires. The distance between the reed switch and the magnet should be around 6 mm with a maximum of 8 mm.

The consumption of the circuit in a 'stand-by' situation is around a few

3

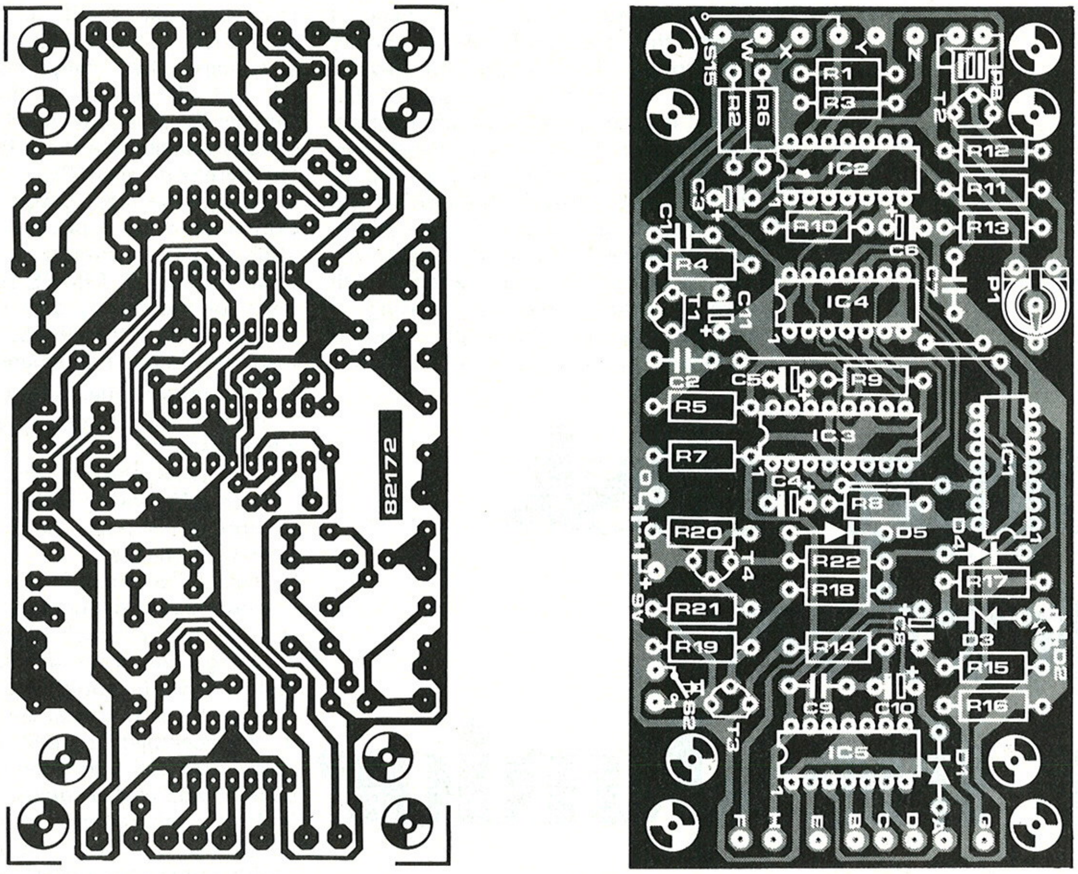


Figure 3. The printed circuit board for Cerburus is shown here. It was designed to fit the type 202-21029J case from Vero. The completed unit should be mounted in a position that is out of sight but can be reached easily in less than ten seconds. All wiring to and from the unit should be hidden if possible.

nA. When activated this increases to about 50 μA, or 10 μA in the 'doorman' mode. For good reliability we strongly suggest the use of alkaline batteries.

Cerberus: mythological multi-headed dog guarding the entrance to the underworld.

Parts list

Resistors:
R1,R3,R5,R6,R15,R20,R21 = 1MΩ
R2 = 10 k
R4 = 10MΩ
R7,R16 = 100 k
R8,R9 = 3M3
R10,R18,R19 = 560 k
R11,R12 = 56 k
R13 = 1 k
R17 = 100 Ω
P1 = 50 k preset

Capacitors:
C1,C2 = 100 n
C3,C6,C8 = 1μF/16V
C4.C5.C10.C11 = 10μF/16V
C7 = 3n3
C9 = 56 n

Semiconductors:
D1,D4,D5 = 1N4148
D2 = LED
D3 = zener 4V7/400mW
T1,T3 = BC 547B
T2 = BC 557B
T4 = BC 516
IC1,IC2, = 4093
IC3 = 4098
IC4 = 4013
IC5 = LS7220

Miscellaneous:
S1 two way double pole switch
S2 press button
S3 . . . S14 12 key keyboard, one common rail. (e.g. TKC type BLE 2)
S15 = reed switch
PB = piezo buzzer (PB2711)

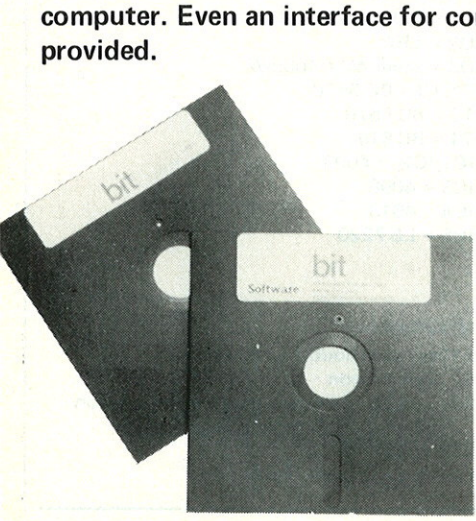
floppy-disk interface for the Junior

. . . and other 6502 computers

G. de Cuyper

At present the floppy disk is the most significant mass storage medium for the computer. Considering the method used for recording, it is almost incredible that computer data can be stored on a simple plastic disk at such speed and with such precision. This article will point out everything that has to be taken into account before one single bit can be stored on the plastic disk. The hardware of the floppy disk interface is designed to be universal. Not only Junior Computer fans, but also the owners of a KIM, SYM, AIM-65, ACORN and other computers can use this low-cost interface to extend their computer to a real personal computer. Even an interface for connecting the EPSON printer is provided.

Computer fever broke out here in Europe about eight years ago. The first 8-bit processors were even available at a hobbyist's budget. The great change, however, came in 1976 when Shugart brought the first 8-inch drive onto the market. Until then computer data had to be stored on punched paper tape or inconveniently on magnetic tape at speeds that are considered extremely slow today. The floppy disk revolutionized rapid data interchange between the computer and an external mass storage device. Rapid paper tape readers only achieved rates of up to 15 kilobaud (baud = bit/second) at best. Paper tape punches were barely able to exceed 700 baud. Unless the user is to go to great expense with magnetic tape recording using a cassette recorder, the upper limit is 1200 baud at a tape speed of 4.75 cm/s.



But even floppy disks have their disadvantages. Although the round plastic disks do not cost more than good chrome-dioxide cassettes, the drive unit for floppy disks is fairly expensive. The computer user will have to pay about 120 to 190 pounds for a floppy disk drive. If one considers that two drives are required for convenient operation with a computer, the investment is quite substantial.

The price barrier

Since the prices for floppy disk drives are not likely to drop much lower, it was decided to save costs in another area when implementing a DOS (DOS = disk operating system) for the Junior Computer. We had to make a choice between employing a floppy disk controller and a controller using a few TTL ICs and some software. The 1771 or 1791 from Western Digital or the Motorola 6843 are suitable as controllers. These chips have the disadvantage that they cost between 17 and 35 pounds. A further disadvantage is that not much 6502 software is available on the software market for these controller ICs.

Our objective was to equip the Junior Computer with a powerful disk operating system, without forgetting the KIM, SYM and AIM-65 friends. Hardware for the floppy disk interface was not to exceed the 35 pound limit. We made the following demands of a DOS:

1. The programmer should no longer have to be concerned with absolute addresses in the computer.
2. The DOS should operate together with a Microsoft BASIC. The BASIC interpreter should understand DOS macro commands.
3. The DOS should operate with a convenient debugger. A debugger is a program which allows software to be generated in machine language and tested. It should also be possible to place break points at any locations.
4. An assembler and editor should also be provided and should understand various DOS macro commands.
5. If the programmer makes an incorrect input, the computer should enable immediate analysis of the syntax and operating errors with precise error messages.
6. There should be a lot of good and cheap software available on floppy disks for the DOS:
   - Games programs
   - Bookkeeping programs
   - Programs in BASIC and Assembler
7. The DOS must be easily adaptable to any 6502 computer.
8. The DOS must be capable of generating random files. Random files are data files on the floppy disk into which data are written and which are produced during execution of a BASIC program.

As can be seen from these requirements, we made high demands of the disk operating system. For this reason we chose an operating system that is widely used in the USA and Europe: the DOS is from Ohio Scientific and is known as the 'Ohio Scientific OS-65D Operating System'.

Ohio Scientific also supplies the popular computers 'superboard C1P, C4P and C8P'. The software developed for these computers (and there is a good deal of it) can be easily adapted to the Junior Computer and other 6502 systems by modifying a few bits in the DOS main program (called KERNEL). Two versions of Ohio's DOS are available at present:

1. OS-65D V3.1 consisting of

1

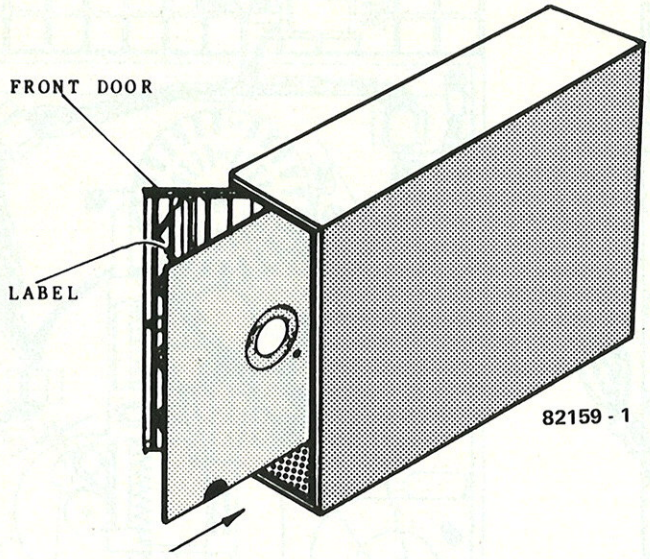
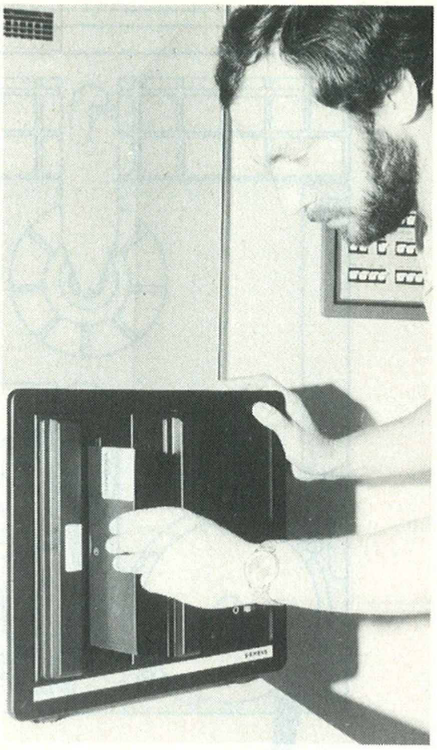


Figure 1 shows how a diskette is inserted into the drive. The label of the diskette faces the door of the drive.



- A 5-inch diskette
- A manual of approximately 75 pages.
- The price of OS-65D V3.1 including manual is approximately 30 pounds — relatively inexpensive.

2. OS-65D V3.3 consisting of
   - Five 5-inch diskettes accommodating various user-support programs (more than 17 utility programs altogether, which greatly facilitate programming).

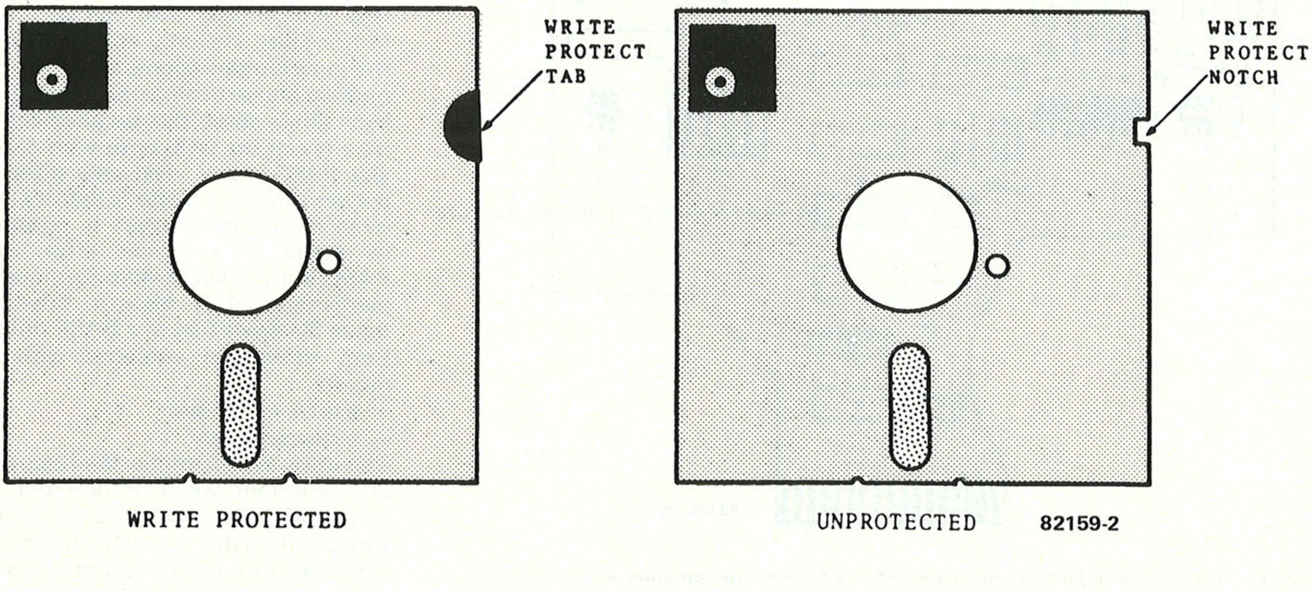
   All programs are written in BASIC and can thus be easily modified by the user if necessary.
   - A fresh diskette
   - A 250-page manual and detailed instructions for working with the DOS, BASIC and Assembler. Also contained are a BASIC manual and an Assembler manual.
   - The price of OS-65D V3.3 including all manuals is approximately 60 pounds. Considering the expensive documentation of OS-65D V3.3, this price is certainly justified to say the least.

We adapted both versions to the Junior Computer and both versions have been working for many months without any problems and to our full satisfaction.

Before being able to work with the extensive DOS from Ohio Scientific, however, a good deal must be known about the operating system. The Ohio manuals are very well written, but one must be familiar with computer techniques to understand the manuals. For this reason we shall try to provide our readers with the necessary knowledge concerning a disk operating system, step by step. First we shall generally describe the manner in which the data are stored on a floppy disk and will then discuss the recording method of Ohio Scientific. A functional description of the mechanical aspects of a floppy disk drive will also be included.

As shown in figure 1, each floppy disk drive has a door at the front. This door must be opened to insert or remove a diskette. The door should not be closed until the deskette has been fully inserted into the drive. Otherwise there is a risk of damaging the diskette. Fitted to the door of the drive is a switch which closes a contact when the door is closed.

2



WRITE PROTECTED

UNPROTECTED

Figure 2. The diskette has a notch on one edge. If this notch is covered by a non-translucent medium, the diskette is write-protected.

3

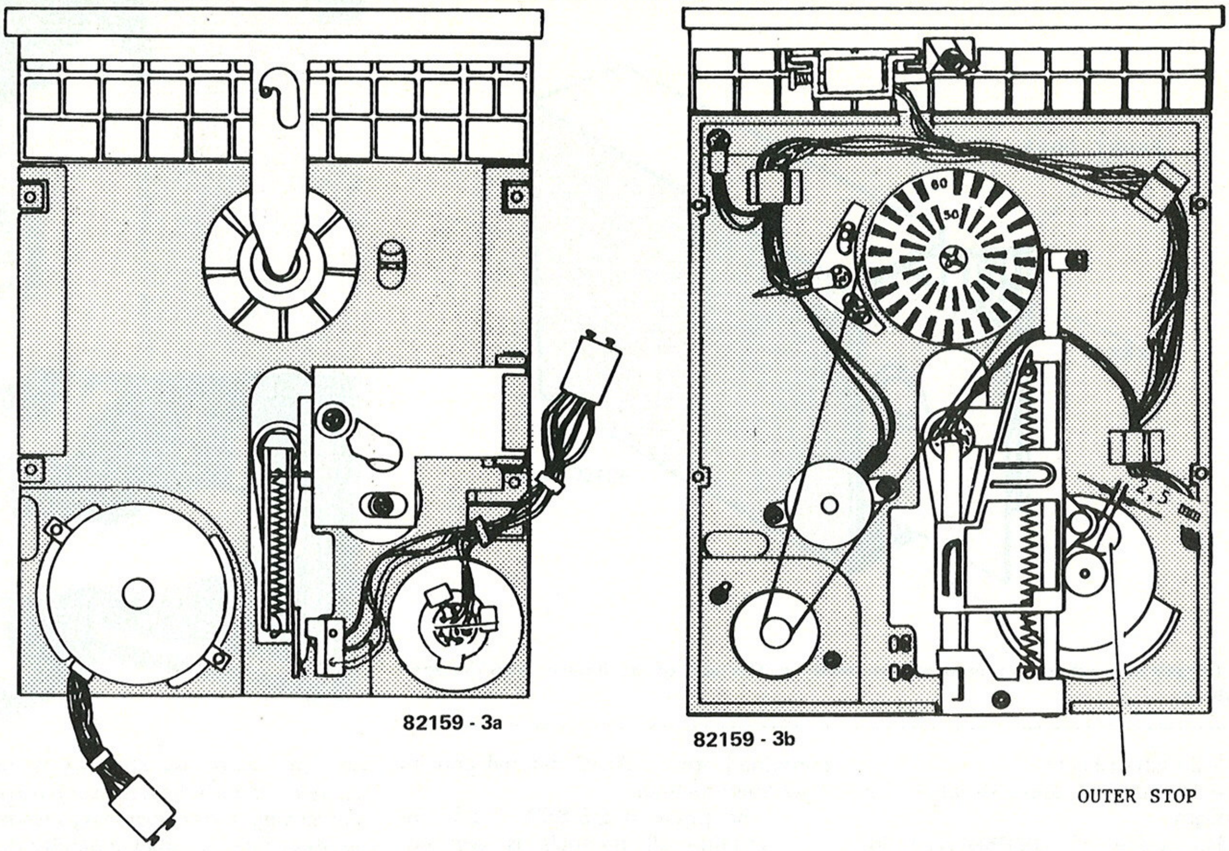


Figure 3a shows a Shugart drive and figure 3b shows a BASF drive.

4

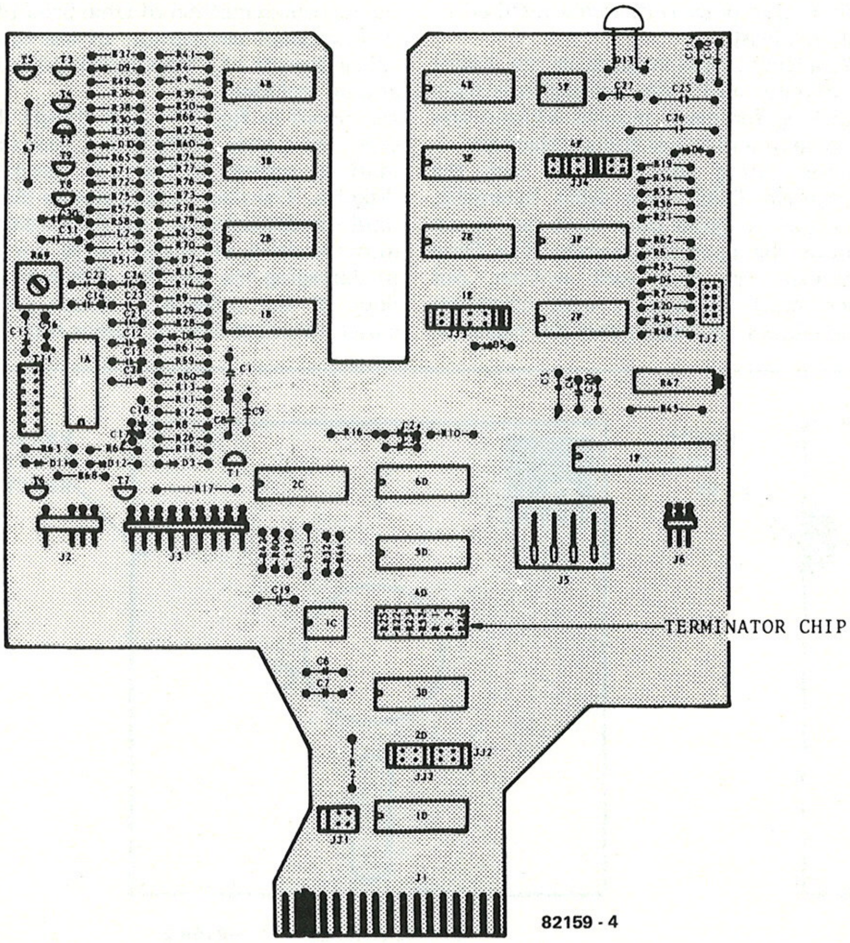


Figure 4. This is the component side of a BASF 6106 drive. The computer transmits and receives data to and from the drive via J1. Plug JJ1 is in position 'A'. The plug of JJ1 must always be in the position shown when a drive is used.

Thus the computer can only write data onto the diskette or read data from it when the door is closed.

Diskettes can be protected against accidental overwriting. As can be seen in figure 2, there is a notch in one side of the diskette. An optoelectronic device in the floppy disk drive monitors this notch to establish whether it is open or covered. If the notch is covered the diskette is protected against accidental overwriting. If the programmer attempts to write data onto a write-protected diskette the DOS issues an error message.

Any floppy disk drive can be utilized in principle. The only condition is that the input/output connector of the drive must be Shugart-compatible. Most 5 1/4-inch drives meet this requirement. We have tested the DOS both with Shugart and BASF drives. The only difference between the two drives is that the read/write head with Shugart is positioned by means of a spindle drive, whilst BASF use a helix. Figure 3a shows the mechanism of a Shugart drive and figure 3b shows that of a BASF drive.

Both drives are equipped with two motors:

— a drive motor and
— a stepper motor.

The drive motor rotates the floppy disk at a constant speed of 360 rpm. The drive motor is connected to an electronic regulator which keeps the rotational speed of the diskette constant, even in the event of load variations. The rotational speed of the diskette can be varied within certain limits on both drives. The second motor is a stepper motor which handles the positioning of the read/write head of the drive. This motor is also connected to electronic control circuitry. The control circuitry is fed with pulses by the computer. Each pulse switches the stepper motor one step further. Another line is connected between the computer and the control circuitry of the stepper motor. The potential on this line determines whether the stepper motor is to move the read/write head outwards from the interior or vice versa.

The drive chassis also contains three other electromechanical components:
As its name implies, the task of the head-load solenoid is to lower the read/write head onto the magnetic surface of the diskette. If the head-load solenoid is not activated, the read/write head is raised from the surface of the diskette by a spring. On the BASF drive the head is rigidly mounted. A felt pressure disk presses the magnetic surface of the diskette against the head.

Two optoelectronic sensors are located on the drive chassis. One of these sensors emits a pulse when the read/write head is over 'track zero' (described in more detail at the end of the article). Track zero is a special recording track on almost all floppy disk drives.
The second sensor monitors the index hole which is punched in the diskette. The index hole (see figure 2) is the absolute zero mark of the diskette or, to put it another way, the 'zero degree mark' on the round plastic disk. The index hole serves to inform the computer when the diskette has made a full revolution. Thus at 360 rpm an index pulse is emitted every 166.66 ms.

To summarize, therefore, a floppy disk drive consists of the following components:

- A stepper motor for positioning the read/write head
- A drive motor to rotate the diskette at a constant speed
- An optoelectronic sensor that checks whether the read/write head is positioned over track zero
- An optoelectronic sensor that establishes whether the diskette is write-protected
- An optoelectronic sensor that monitors the index hole and emits a pulse every full revolution
- A head-load solenoid that lowers the read/write head onto the magnetic surface of the diskette.

Clearly, a good deal of electronic circuitry is required to control all the electromechanical components on the drive chassis. Read/write amplifiers are also required for the head in the drive. These amplifiers can be compared with the recording and playback amplifiers in a conventional tape recorder. However, the read/write amplifier in the drive must be able to process frequencies of approximately 125 kHz, because the baud rate for our floppy disk interface is 125 kilobaud.

All this extensive circuitry is installed in a floppy disk drive and obviously contributes to its high cost. Usually the electronic circuitry in the drive is prealigned. There is therefore no difficulty involved in connecting a drive to the Junior Computer. Figure 4 shows the printed circuit board for a BASF drive. Only two connectors are important to the user: J1 and J5.

Connector J1 is the Shugart-compatible connector of the drive. All control signals of this connector have TTL levels. All control signals emitted by the floppy disk interface are fed to the electronic circuitry in the disk drive via J1.

Connector J5 is also Shugart-compatible and is utilized for the supply of power. The disk drive requires two voltages: 12 V/800 mA and 5 V/300 mA. Since the power consumption of a DOS computer is fairly high, we shall examine the question of power supplies in a future issue of Elektor.

Any user wishing to connect two or more drives to his computer must also

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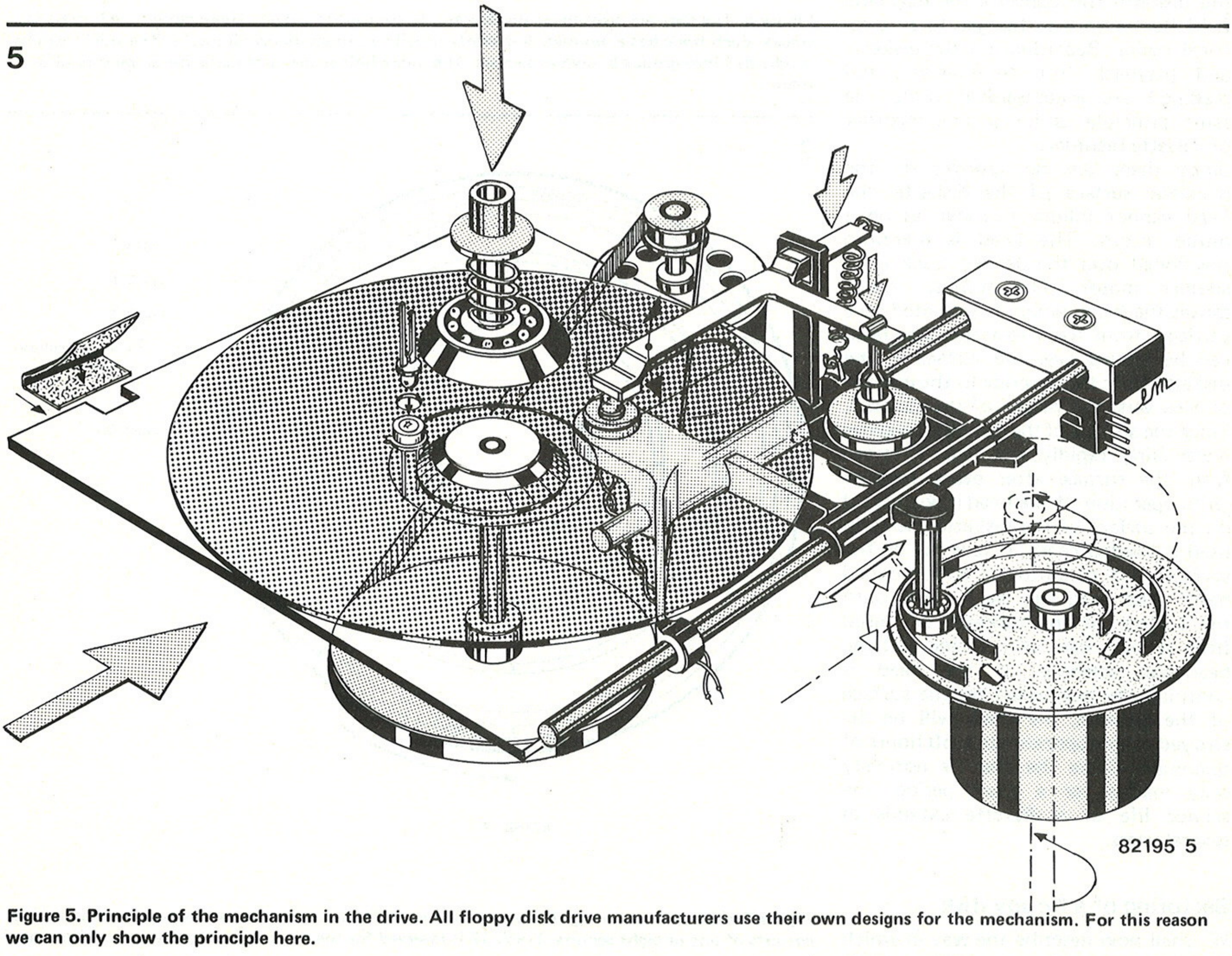

Figure 5. Principle of the mechanism in the drive. All floppy disk drive manufacturers use their own designs for the mechanism. For this reason we can only show the principle here.

take into account connector JJ1 and the terminator chip:

The terminator chip contains eight pull-up resistors and is always located in the last drive, when more than one are connected. When two drives are connected to the Junior Computer, drive A (the first one) has no terminator chip whilst drive B (the last one) contains the terminator chip. If, for example, four drives are to be connected to the Junior Computer, drives A . . . C contain no terminator chips whilst drive D (the last one) contains a terminator chip.

The drive designated as A, B, C or D is selected on JJ1 with the shorting plug. Drieve A is selected with the position shown. The following plug positions are assigned to drives B and C. Drive D does not require a shorting plug because it is clearly identifiable by the terminator chip.

Resistor R69 is for fine adjustment of the read amplifier. This resistor should never be readjusted. The quality of the read signal depends on it (freedom from jitter).

Drive mechanism

Figure 5 shows a sketch of a drive mechanism. The floppy disk is rotated by the drive motor like a record. The head makes contact with the surface of the diskette and converts the magnetic field fluctuations in the gap to an electrical signal. Recording on the diskette and playback from it ('writing and reading') are accomplished using the same principle as for a tape recorder or cassette recorder.

Since there are no grooves on the magnetic surface of the diskette, the head cannot follow a groove as on a music record. The head is therefore positioned over the desired track by a stepper motor. The stepper motor moves the head, which is mounted on a carriage, from track to track. The head can be moved over the surface of the diskette from the exterior to the interior or vice versa by means of the carriage. Since the surface of the diskette becomes worn fairly rapidly, the head is raised from the surface after every read or write operation. If the head is positioned on the surface of the diskette the term used is 'loaded head'. If it is not on the surface, this condition is an 'unloaded head'. The head can be lowered onto the surface of the diskette or raised from it by means of a spring and the head-load solenoid. If the head is continuously positioned on the surface of the diskette, the track will be destroyed after approximately 50 hours of operation. Since the head is normally only loaded for a short period, the service life of a diskette extends to several years.

Sectoring of a floppy disk

We shall now describe the way in which the data are stored on a diskette. With

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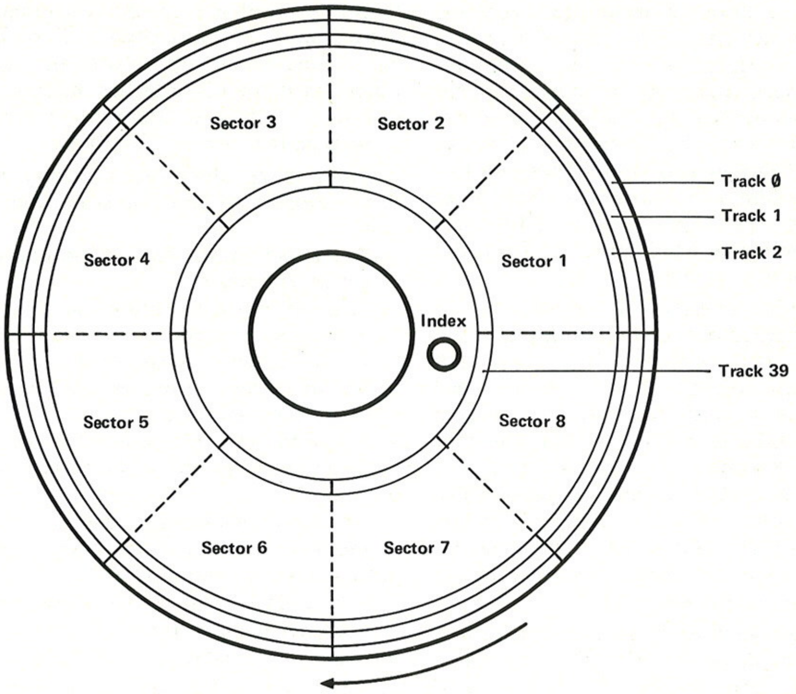


Figure 6. The data are written on the diskette in concentric circles. These circles are known as tracks. Each track has a number. A diskette usually accommodates 40 tracks. The tracks can be subdivided into groups known as sectors. The index hole is the start mark for all sectors of a track.

7

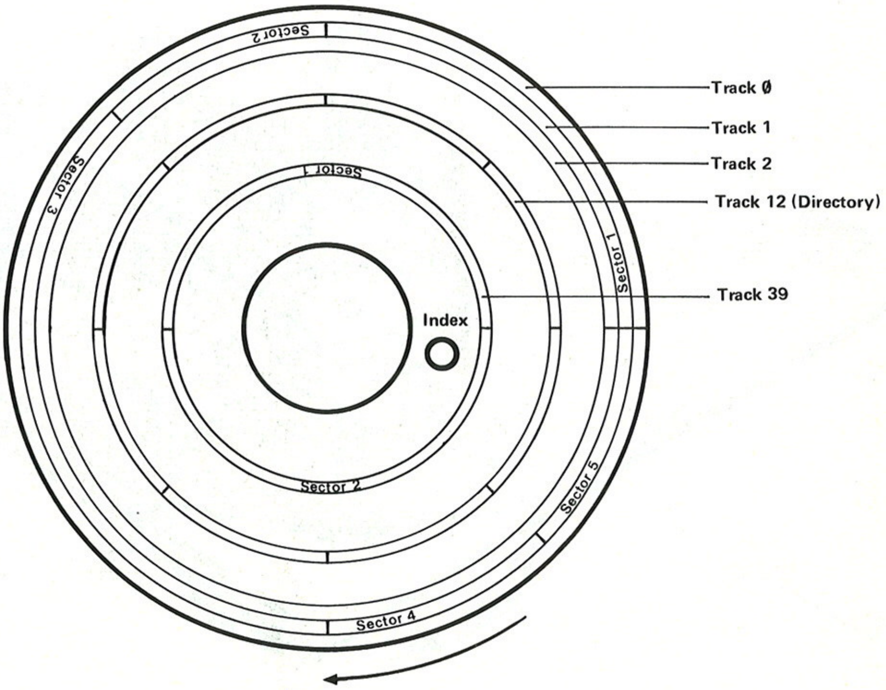


Figure 7. With soft-sectoring, the sectors can be of different lengths. In the extreme case a track consists of one or eight sectors. Track 12 is reserved for the directory with the Junior Computer.

8

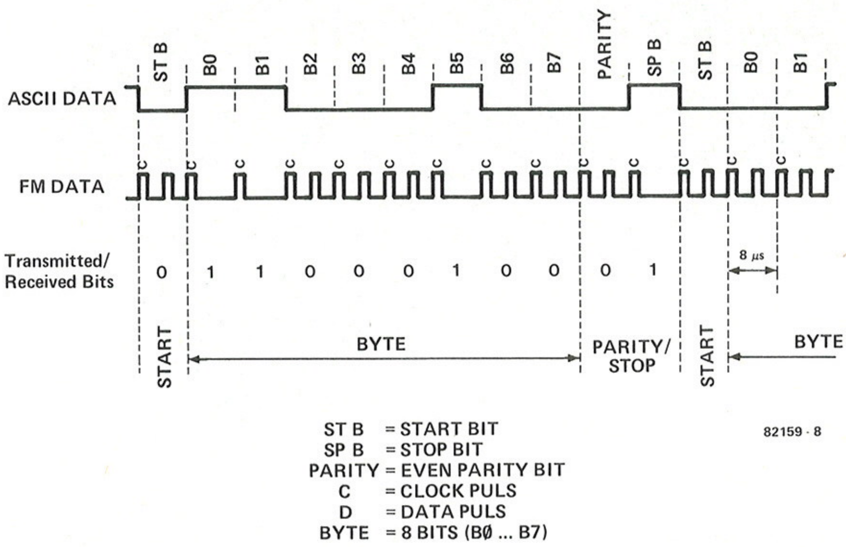


Figure 8. This is the transmission format of the floppy disk interface.

floppy disks of the type used for the Junior Computer, the data are stored on 40 concentric rings. The width of one ring is only 0.2 mm. The outermost ring of the diskette is track zero. With most disk operating systems (including the OS-65D) this is a reference track for the other tracks on the diskette. Figure 6 shows that the diskette is further subdivided. In addition to the 40 tracks, the diskette is subdivided into sectors. For the sake of simplicity, we have used eight sectors in the example. Sector 1 always comes soon after the index hole. With OS-65D there is always a wait of 1 ms until the index pulse has decayed. Only then are the data written into the corresponding sector of the track.

There are very many formats for sectoring a diskette. The best known format is the IBM-3740 format which is not employed by Ohio Scientific. For this reason we shall not discuss the IBM format but will deal only with Ohio's own format.

The track number and sector number allow a data block written on a diskette to be clearly identified. The diskette in figure 6 has sectors of the same lengths. It is possible, however, to place sectors of different lengths on one track. The minimum data length accommodated in one sector with Ohio Scientific is a 6502 page or 256 bytes. Thus the track number and sector number are the coordinates with which a data block can be found on the diskette in fractions of a second.

Figure 7 shows the sectoring of a diskette with variable sector lengths. This format is also used by the DOS which we have adapted to the Junior Computer. Track zero, the outermost track of the diskette, has a particular write format which will be explained later. Track 1 is subdivided into several sectors: sector 1 contains two pages, i.e. 2-times 256 bytes.

A 45-degree rotation of the diskette corresponds to a data block of 256 bytes or one page. Sector 2 on track 1 is only half as long as sector 1 and only contains 256 bytes. Sector 3 on track 1 contains 5 pages. Thus 5-times 256 bytes are stored in sector 3 on track 1.

It is possible, however, to place only one sector on a track. This is the case with track 2 in figure 7. If only one sector is placed on a track, a maximum of eight pages can be stored per track, i.e. 2048 bytes. Since specific formatting information per sector, i.e. additional bytes which require space, is written on the diskette it is advisable for safety reasons not to write more than seven sectors per track on the diskette.

Track 12 has a special function. This track holds the directory of the diskette. By means of the BASIC interpreter it is possible to store a file in the computer (for example, a BASIC program, a shopping list or a love letter). A file is created in the computer when the programmer presses keys on a terminal and the computer files the information in the memory, key by key.

For any programmer it is difficult or even impossible to make a note of the track and sector in which the program or file is stored on the diskette. For this reason the Ohio DOS offers the facility for assigning names to the programs. A program name or file name may have a maximum of six alphanumeric characters and the first character must be an alphabetic character (A . . . Z). If, for example, you have written a BASIC program for calculating a circle and wish to store this program on a diskette, you can assign the program a name. You could use the name 'CIRCAL' for instance, as an abbreviation for circle calculation. You write the name 'CIRCAL' onto the diskette quite simply by typing:

DISK! 'PUT CIRCAL'.

The computer then 'puts' the program on the diskette. The inverse of the PUT command is the LOAD command:

DISK! 'LOAD CIRCAL'.

This causes the file to be loaded into the computer. We shall explain the commands of the disk operating system later.

Before the computer can write a file onto the diskette or read one from it, the file name must exist in the directory. Ohio supply various system service routines on diskettes to be able to generate file names in the directory.

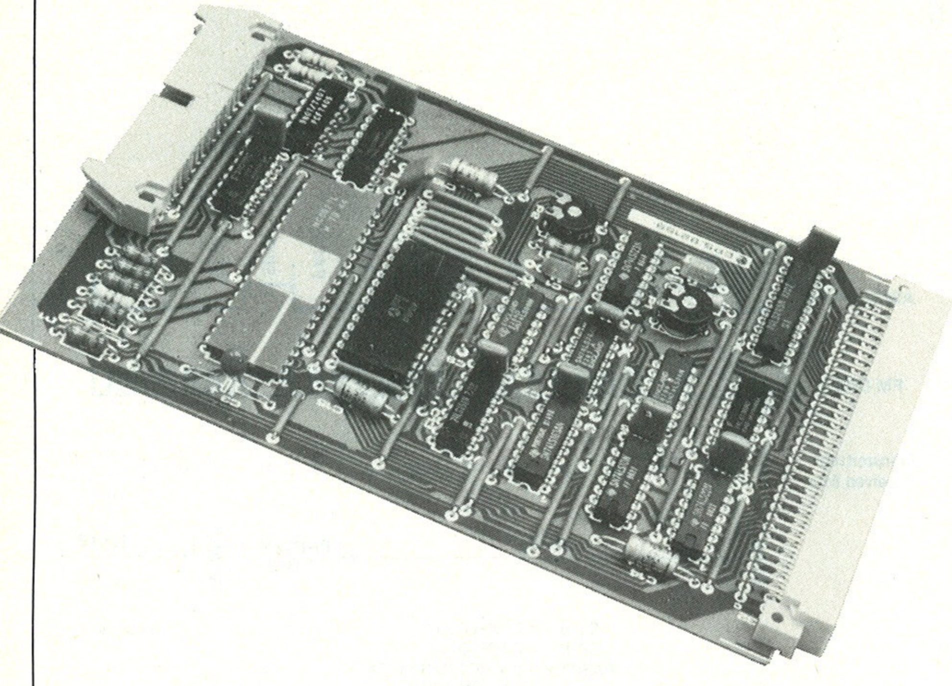
Data pulse to the floppy disk drive

At the end of this article we will demonstrate the electrical signals which the computer sends to the disk drive. Ohio use a very simple transfer format. The data are transferred asynchronously, as with the printer interface of the Junior Computer. Although the printer interface can only handle a maximum of 2400 baud, the floppy disk interface can transfer at 125000 baud. An MC 6850 ACIA, which costs less than 2 pounds, allows this high transfer rate.

The serial data delivered by the asynchronous interface adaptor (ACIA) have the following format:

- One start bit
- Eight data bits
- One even-parity bit
- One stop bit

The even-parity bit is a check bit with which any transfer errors can be traced. This bit is set when the number of set bits in the transferred byte is an even number. Unfortunately the electronic circuitry in the disk drive cannot process the serial signal of the ACIA. For this reason the serial data signal must be converted to a frequency-modulated signal. Figure 8 shows how this conversion takes place. At the start of each data bit, a narrow clock pulse of only a few hundred nanoseconds is generated. If the transmitted bit is a



logic 1, a data pulse 'D' is modulated between two clock pulses 'C'. If the transmitted bit is a logic zero no data pulse 'D' is modulated between two clock pulses 'C'. As can be seen from figure 8, the electronic circuitry of the disk drive is presented with a frequency-modulated voltage for transmitting the data. The time elapsing until a bit has been transmitted is only 8 microseconds.
For receiving data from the disk drive the frequency-modulated signal must be converted back to a serial data signal. This task is performed by a data separator which is located in the floppy disk interface.
This brings us to the floppy disk interface itself and we will describe its hardware in detail. The following summary indicates everything that is needed to convert a Junior Computer or any other 6502 computer to a DOS computer:

- At least two dynamic RAM cards are needed (see ELEKTOR, April 1982).

To develop large programs, three RAM cards are required.

- A Junior Computer, consisting of the basic printed circuit board, interface card and a bus PCB with five connectors.
- A floppy disk interface card containing a few TTL ICs, an MC 6850 and an MC 6821.
- One or two (if possible) floppy disk drives which have Shugart-compatible connections:

For example the 5 1/4 inch disk drive from BASF, Shugart, TEAC, etc.
Low-cost, surplus disk drives can also be utilized.

- A power supply unit which delivers the following voltages:

+5 V/5 A
+12 V/2.5 A
+12 V/400 mA
–5 V/400 mA
–12V/400 mA

Hardware of the floppy disk interface

A brief study of the circuit diagram of the floppy disk drive (figure 9) shows that only standard, commercially available components have been utilized. We think we have reason to be pleased with this circuitry: this universal floppy disk interface is the lowest-cost interface available on the market at present. All KIM-1, AIM-65 and SYM owners can upgrade their computers from cassette to floppy disk system. However, before the floppy disk interface can be connected to the computer the user should know how the hardware functions. We shall now turn our attention to these interesting technical details.

Data transfer between computer and floppy disk drive

The principle of data transfer between the computer and floppy disk drive can be described as follows:

- The STEP and the DIR line (outputs)

Via the peripheral interface adapter (PIA) IC5 the read/write head of the disk drive is placed on the desired track. The computer emits stepper-pulses via PB3 which are matched to the electronic circuitry of the drive by driver N18. The read/write head is shifted one step inwards or outwards with each pulse. PB2 of the PIA (IC5) and N19 generate the DIR signal. The logical level on the DIR line determines whether the stepper pulses shift the read/write head outwards from the interior or vice versa.

- The TRO line (input)

The TRO line is an acknowledge line from the drive to the computer. The logic level on this line indicates whether the read/write head is placed over track zero.

- The INDEX line (input)

The Index line is an acknowledge line from the drive to the computer. As explained at the beginning of this article, the index hole on the diskette is a zero mark for a soft-sectored diskette. Whenever the index hole passes a light barrier in the drive a pulse is produced on the Index line.

- The WR.PROT line (input)

The logic level on the WR.PROT line informs the computer whether it is allowed to write on the diskette in the selected drive, or whether the diskette is write-protected. The computer only writes on the diskette when the WR.PROT line is inactive.

- WRITE line (output)

The WRITE line switches the electronic circuitry in the disk drive from the read mode to the write mode. Before this line become active, the computer checks via the WR.PROT line whether the diskette is write-protected. If this is the case, the WRITE line can never become active.

- The SEL1, SEL2, SEL3 and SEL4 lines (outputs)

The computer selects one of four drives via the SEL lines. Normally only SEL1 and SEL2 lines are utilized. Line SEL1 controls drive A and line SEL2 controls drive B. When Ohio software is used a floppy disk drive must always be connected to SEL1.

- The SIDE SEL line (output)

The SIDE SEL line is not used with the Junior Computer and is intended for later extensions. Special drives containing two read/write heads can be controlled via this line. These drives can write on both sides of a diskette and read back the stored information from both sides.

- The WDA (output) and RDA (input) lines

The computer writes the data in serial form into the electronic circuitry of the drive via the WDA line. The computer reads the serial data from the drive via the RDA line. The baud rate on these lines is 125 kilobaud. The data transfer from the computer to the drive can be compared to a simple V24/RS232 serial interface. We became acquainted with this interface in the Junior Computer 3 and 4 books. In that application the data are transferred from the computer to the ELEKTERMINAL or from the ELEKTERMINAL to the computer.
The serial data transmitted by the computer to the drive are written in parallel into the ACIA (IC11) and transmitted serially at the TxD output at a rate of 125 kilobaud.
The serial data from the ACIA cannot be directly written onto the diskette. This requires modulation of the serial data with clock pulses which initiate the start of a data bit, as shown in figure 8. Between two clock pulses, a data pulse is then modulated or not, depending on the logic level of the current data bit.
When the computer reads data from the

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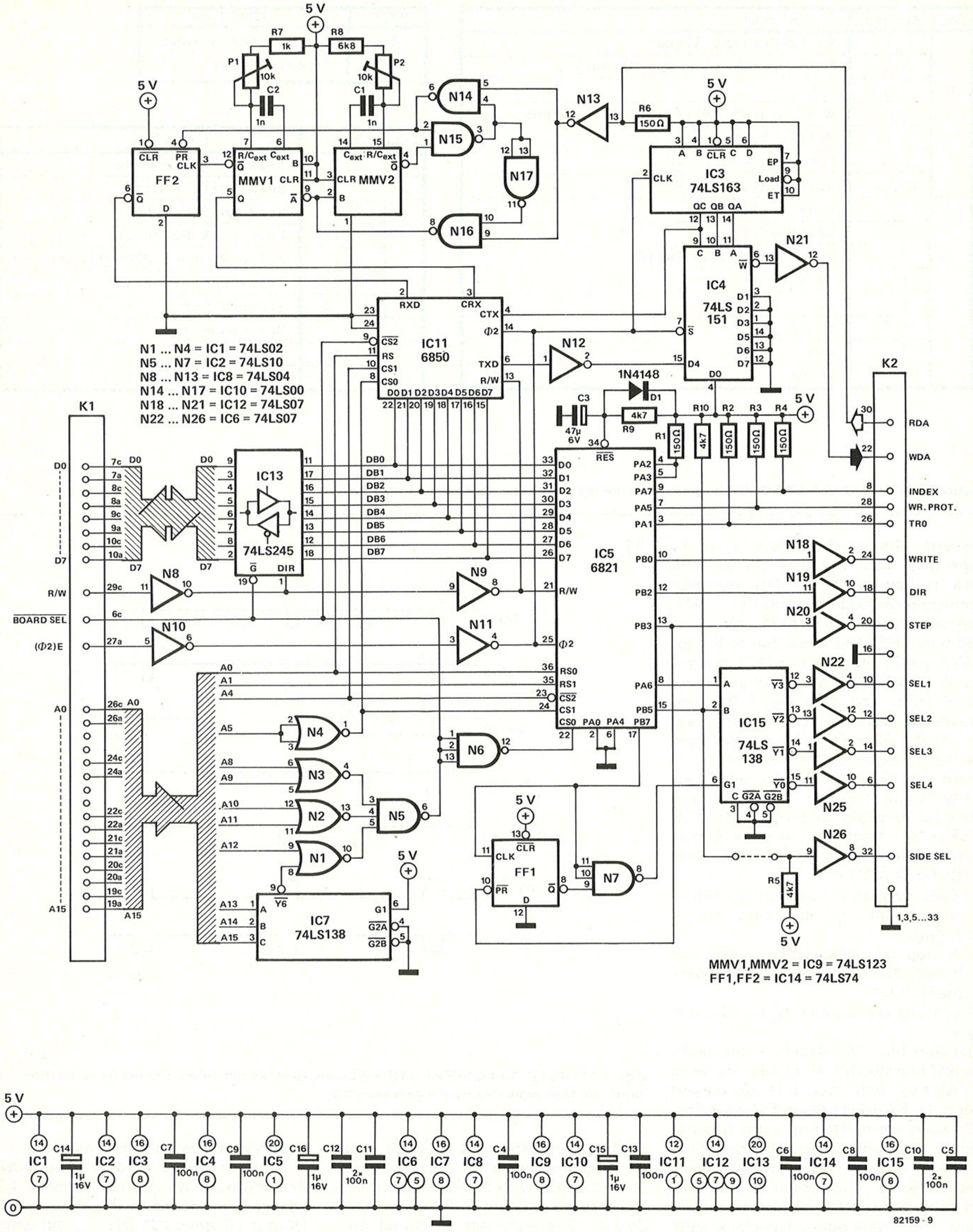

Figure 9. Circuit diagram of the floppy disk interface. Since the data interchange between the computer and drives is controlled by software, one saves the cost of an expensive floppy disk controller. Only standard components are utilised in the circuit.

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Test Points		Signal
TJ1	1,2	Write Current Signal
	3,5	Read Signal (Preamp. Output)
	6	GND
	7,9	Read Signal (Differentiator Input)
	8	Jitter Voltage
	10	Erase Current T.P.
	11,12	Write Current T.P.
TJ2	1	DISK CHANGE FF/
	2	PWRONRESET/
	3	N.O. TRACK ZERO SWITCH
	4	IN USE- FF
	5	MOTOR ON
	6	TRACK 00
	7	GND
	8	INDEX

POTI	FUNCTION
R 47	Drive Motor Adjust
R 69	Jitter Adjust

Connector		Function
J1		Signal - Interface
J2		Read/Write - Head
J3	1,3	Head Load Solenoid
	2,4	Door Lock Solenoid
	5,6	Write Protect Phototransistor
	7,8	Index Phototransistor
	11-18	Stepper Motor
J5		DC- Connector
J6	2,4	Drive Motor
	3,5,6	Track Zero Switch

Figure 10. WRITE DATA ENCODER diagram. Here are the pulses that are emitted to the drive.

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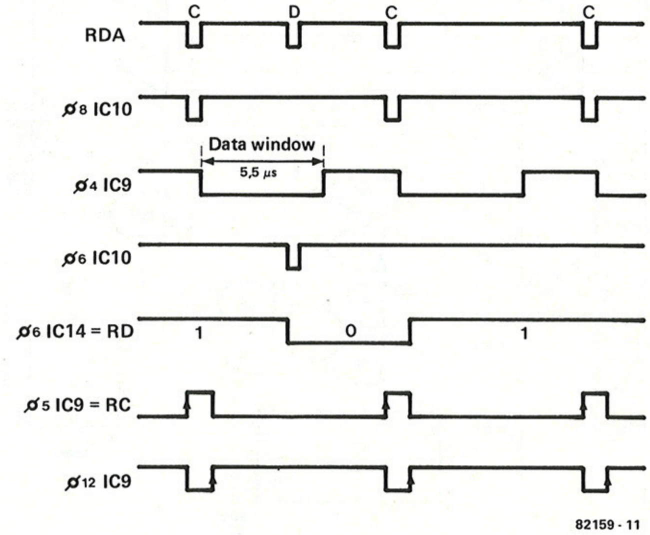

Figure 11. READ DATA SEPARATOR diagram. Here are the pulses arriving from the drive and which are then separated by the data separator.

diskette the clock pulses must be separated from the data pulses. This task is handled by a data separator consisting of components N13 . . . N17, the two monostables MF1, MF2 and flip-flop FF2. The clock pulses for the ACIA are at output Q of MF1 and the serial V24/RS232 data are at output Q of FF2. The data signal that was previously in serial form can be read out of the ACIA (IC11) in parallel form by the computer via the data bus.

Since the I/O chip used for serial data transmission between computer and drive is normally employed for V24/RS232 interfaces, a number of known characteristics are found in the transmitted data pattern:

1. Each byte to be transmitted begins with a start bit and ends with a parity bit.
2. A stop bit is located between two bytes. The stop bit is the inverse of the start bit.

Eleven bits are required to transfer one byte:

One start bit, eight data bits, one parity bit and one stop bit. If no data are being transferred, only stop bits are present (logic 1). By using pseudo-FM-encoding, 22 pulses are written onto the diskette during the transmission of one byte (= 8 bits), which only consists of logic ones (= $FF). The reason is that each bit to be transmitted consists of a clock pulse and a data pulse. The clock pulse is always present, whilst the data pulse is only present when a logic one is being transmitted (see figure 8).

This format allows eight pages of 256 bytes each to be stored on one track, i.e. 8-times 256 bytes = 2 kilobytes. Since a few tracks are required for the directory and system program (= DOS program and BASIC), only 35 tracks available to the programmer on a diskette with a total of 40 tracks. Thus approximately 2 kilobytes times 35 = 70 kilobytes can be stored on a diskette. This is more than adequate for a hobby computer system.

The circuit diagram in detail

The circuit diagram of the floppy disk interface can be subdivided into several groups which we shall now examine:

a. Address decoding and data buffer

The outputs of address decoder IC7 change their states in 8-kilobyte steps. Output Y6 drives IC1 (N1 . . . N4) which decodes the rest of the address lines. If all inputs of gate N5 are logic ones, its output (pin 6) becomes a logic zero. This output always remains a logic zero between addresses $C000 . . . $C0FF. This signal is needed to activate the data bus buffer in IC13. Additionally, the output is wired to pin 6c of bus connector K1.

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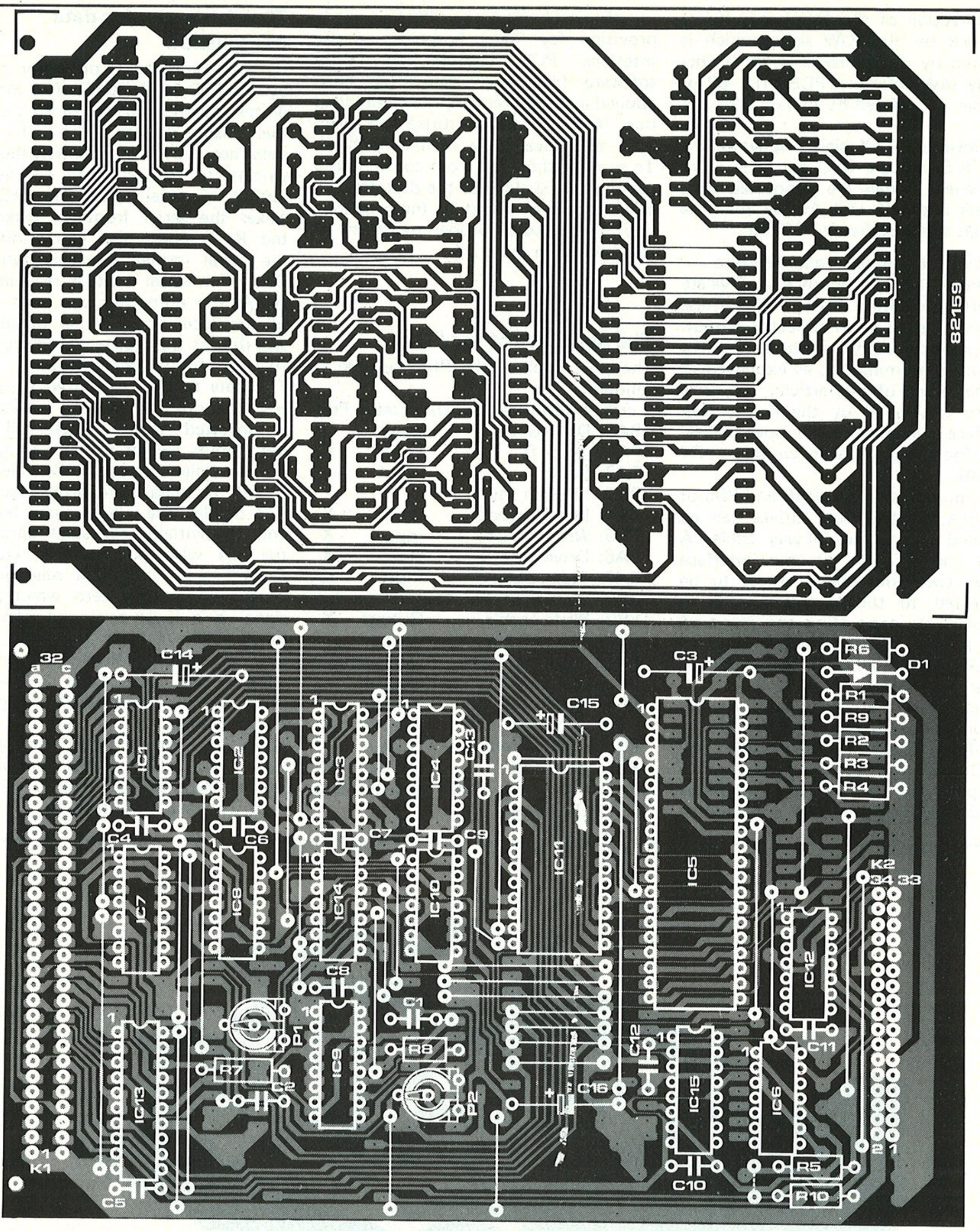


Figure 12. Layout and component overlay of the PCB of the floppy disk interface. Use great care in soldering, because some tracks are very close to each other. Good sockets should be utilised for IC5 and IC11.

Parts list

Resistors:
R1,R2,R3,R4,R6 = 150 Ω
R5,R9,R10 = 4k7
R7 = 1 k
R8 = 6k8
P1,P2 = 10 k trimmer potentiometers

Capacitors:
C1,C2 = 1 n MKT
C3 = 47 μ/6,3 V
C4 . . . C13 = 100 n
C14,C15,C16 = 1 μ/16 V

Semiconductors:
D1 = 1N4148
IC1 = 74LS02
IC2 = 74LS10
IC3 = 74LS163
IC4 = 74LS151
IC5 = 6821
IC6,IC12 = 74LS07
IC7,IC15 = 74LS138
IC8 = 74LS04
IC9 = 74LS123
IC10 = 74LS00
IC11 = 6850
IC13 = 74LS245
IC14 = 74LS74

Additionally:
64-way male connector, rows a and c fitted (Siemens)
Two 34-way female connectors for ribbon cable
Mating plugs for the above for fitting to the PCB, angled
(Molex, Amphenol, ITT-Cannon, etc.)

The direction of the data bus buffer is governed by the R/W signal which is buffered by drivers N8 and N9 on the floppy disk interface PCB. The 02 or E-signal is buffered by drivers N10 and N11.

The inverse COXX signal activates the PIA (IC5) via the CSO pin. The other chip select signals are connected with address lines A4 and A5, so that the PIA has a base address of $C000.

b. *Lines between drive and interface*

The outputs to the floppy disk drive are buffered by drivers N18 . . . N26. These drivers have an open collector output. The pull-up resistors are always in the last drive (terminator), as explained at the beginning of this article. The drive is also controlled by the floppy disk interface via drivers with open collectors. The pull-up resistors are R1 . . . R4 and R6.

IC15 multiplexes lines PA6 and PB5 of the PIA, so that four drives can be operated using one 34-way cable. A small modification on the interface allows two doublesided drives to be connected to the computer. This is achieved by connecting the input of N26 to PB5. The connection between PB5 and pin 2 of IC15 must be disconnected in this case.

Multiplexer IC15 is activated via N7. The inputs of N7 are controlled by the head-load output of the PIA (PB7) and the Q-output of FF1. FF1 is set by the step pulse and reset by the leading edge of the head-load pulse. N7 and FF1 are not absolutely necessary. We have made provision for them, however, on the interface PCB because the Ohio software for 8-inch drives has been applied and requires a separate head-load line. Mini-disk drives utilize the select lines to activate the read/write head. To prevent the head from continuously rubbing the surface of the diskette, the select line is activated by the head-load line. This ensures proper treatment of the diskette in the drive.

The port lines of the PIA

The port lines of the PIA are used as follows:

A-side: Address $C000; Disk status Port			
PA0:	Drive 0 ready	Input	
PA1:	Track 0	Input	X
PA2:	Fault	Input	
PA3:	Free for user		
PA4:	Drive 1 ready	Input	X
PA5:	Write protect	Input	X
PA6:	Drive select L	Output	X
PA7:	Index pulse	Input	X
B-side: Address $C002; Disk control Port			
PB0:	Write enable	Output	X
PB1:	Erase enable	Output	
PB2:	Step direction	Output	X
PB3:	Step pulse	Output	X
PB4:	Fault reset	Output	
PB5:	Drive select H	Output	X
PB6:	Low current	Output	
PB7:	Head load	Output	X

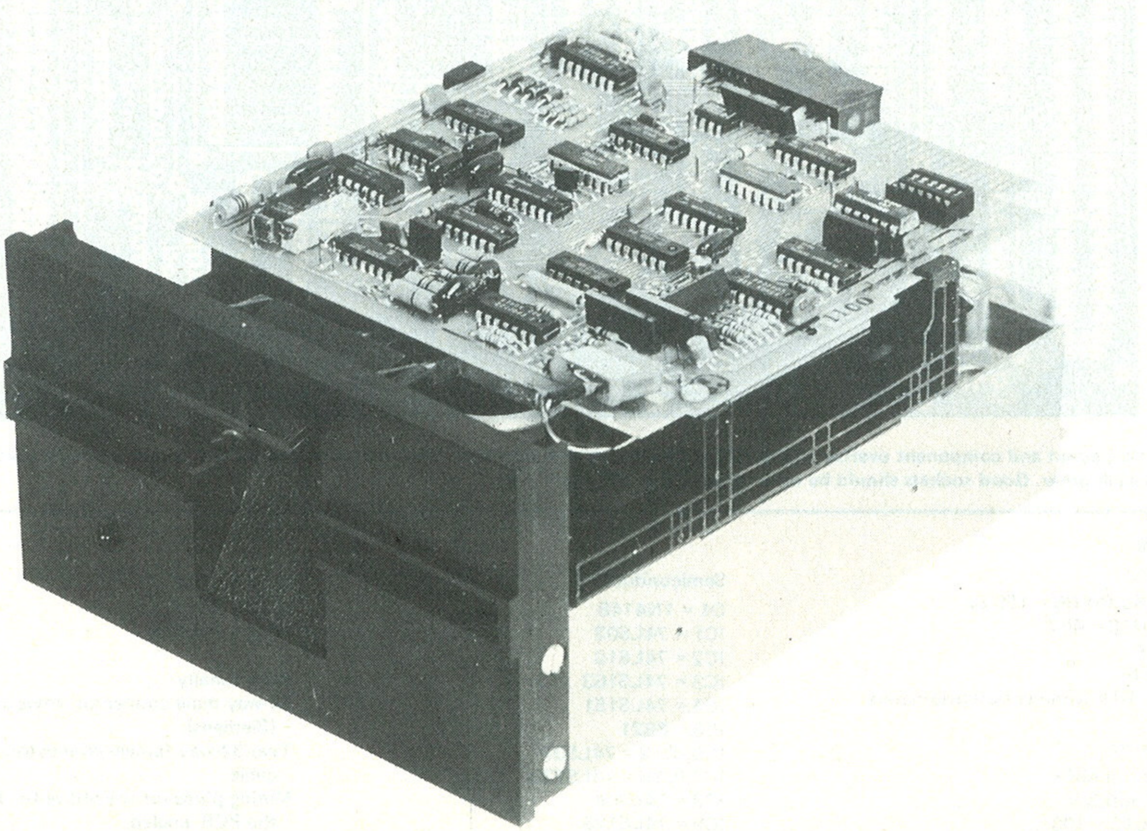
All I/O lines are active at logic zero. 'X' = I/O line used.

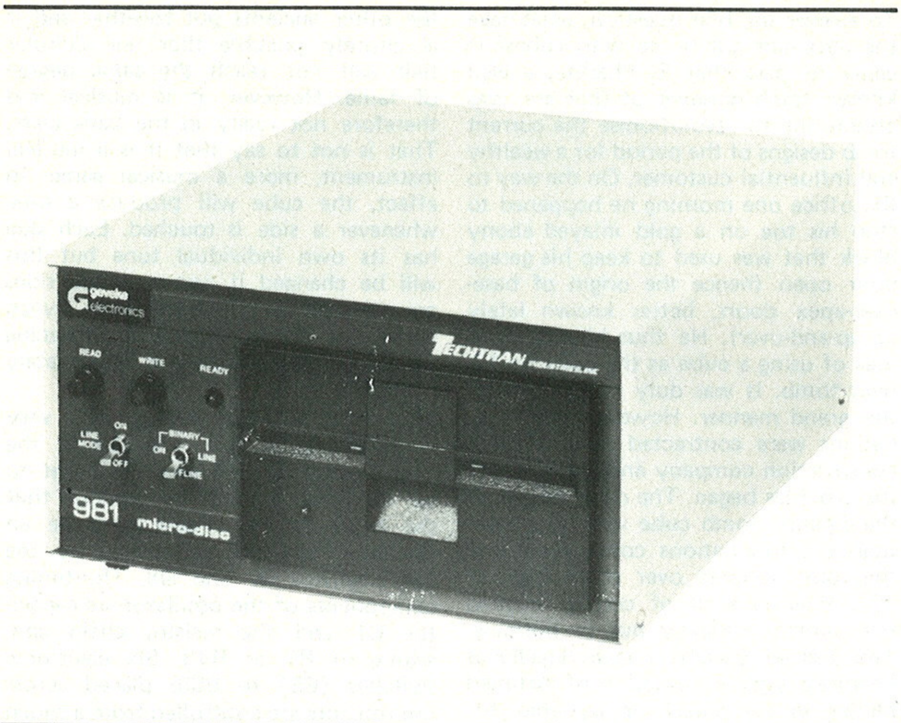
The electronics for data transmission

Data transmission is primarily handled by the 6850 ACIA (IC11). The computer writes the byte to be transmitted into the transmit register of the ACIA via the data bus. IC11 then shifts the word written in parallel form to the TxD output in serial form. The ACIA receives the serial from the diskette at the RxD input. The clock input for the serial receive signal is designated CRx. If a serial word is read into the ACIA the computer can read it out of the receive register in parallel. We will discuss the register structure of the ACIA in the December issue.

The data to be transmitted are presented to input D4 of data selector IC4 in inverted form (N12). All other data inputs except for D0, are grounded. The select input of IC4 selects the 'E' or 02 signal. Synchronous counter IC3 divides the clock signal by eight and sequentially addresses data selector IC4 with outputs QA, QB, QC. Output 6 of the data selector must always be a logic zero when the 'E' signal is a logic zero and when data input D4 is a logic one. This means that a pulse is always produced at address zero. This pulse is the clock pulse which is repeated every eight microseconds.

When the ACIA (IC11) transmits a logic one, TxD is a logic one and D4 of the data selector (IC4) is a logic zero. The result is as follows:





- During transmission of a logic one, no data pulse appears at the 'W' output of the data selector (IC4).
- During transmission of a logic zero, one data pulse appears between two clock pulses at the 'W' output of the data selector (IC4).
- Each clock or data pulse has a length of only 500 nanoseconds.

The signal at the 'W' output of the data selector forms the coded FM signal which is transmitted via buffer N21 to the floppy disk drive. The WRITE DATA diagram for the write encoder is shown in figure 10.

To be able to read back the data from the diskette, the clock and data pulses must be separated again. After separation, the clock pulses are utilized to shift the serial data pulses into the ACIA at a rate of 125 kilobaud. The separating of clock and data pulses is performed by a data separator consisting of N13, N14 . . . N17, MF1, MF2 and FF2.

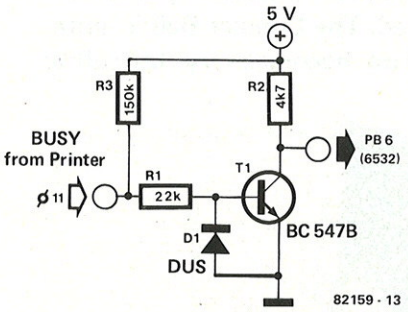
Incoming data from the floppy disk drive are inverted by N13. The NAND port N16 is enabled by NAND N17, so that the first clock pulse can trigger both monostables MF1 and MF2. MF1 triggers on the negative edge of the clock pulse whilst MF2 triggers on the positive edge. The Q-output of MF2 should be at logic zero for about 5.5 microseconds, so that N14 is enabled and N16 is disabled. As soon as a data pulse is present between two clock pulses, flip-flop FF2 is set via N14.

The Q-output of monostable MF1 emits a clock pulse of about 1 microsecond to the CRx input of the ACIA. The leading edge of the clock pulse transfers the data bit currently being transmitted to the serial input register of the ACIA. The data bits come from the Q-output of flip-flop FF2. A data pulse on the preset input sets flip-flop FF2. The Q-output then goes to logic zero. The subsequent clock pulse transfers this zero into the ACIA. When MF1 toggles back to the stable state, it clears flip-flop FF2 via the clock input. Figure 11 shows the timing diagram of the READ DATA separator in detail.

Construction and alignment

Construction and alignment of the floppy disk interface are quite simple. All wire links should first be connected on the printed circuit board (figure 12). Since some tracks are very close to each other, soldering requires great care.

13



(ø11 V24/RS232- connector, Junior Interface Print)

Figure 13. When connecting an EPSON printer with a serial interface, a V24/RS232-to-TTL level converter is required. This little circuit can be wired on the Junior interface PCB in self-supporting fashion. PB5 of the 6532 on the basic PCB of the Junior Computer is used as the BUSY line for the printer.

The resistors, capacitors, diode D1 and the two connectors are then fitted to the board. Trimmer potentiometers P1 and P2 are rotated to their midpoints and soldered into the board. If new ICs are inserted, they can be soldered in directly without sockets. Good sockets should always be employed for the 6850 (IC11) and the 6821 (IC5).

The floppy disk interface should normally work immediately if the two trimmers are set to their midpoints. If, however, fine alignment is still required, the procedure is as follows:

1. Remove the plug from connector K2.
2. Jumper the WDA output to the RDA input on the soldering side of the board using a wire link.
3. Align output Q of monostable MF2 to 5.5 microseconds using an oscilloscope.
4. Monostable MF1 is non-critical and can be aligned to a time of about one microsecond. However, the ACIA and the PIA must then be initialized with a short program. We will go into this in more detail when we discuss the software for the floppy disk interface in the December issue.

EPSON interface

In the Elektor laboratory the Junior Computer operates with an EPSON printer and has therefore been equipped with an interface for the EPSON dot-matrix printer. The following is a description of the necessary interface, for those readers who employ one of these printers.

For connection to the Junior Computer, the EPSON requires a serial interface adapter and not the usual Centronics interface. The commercial price for the serial interface adapter for the EPSON is approximately 23 pounds. The baud rate must be set to 1200 baud by means of the digiswitch provided on the printed circuit board. The ELEKTERMINAL should also run at this rate. The EPSON is connected in parallel to the V24/RS232 output of the ELEKTERMINAL. The EPSON uses the BUSY line to inform the computer whether data can be transmitted to the printer or not. Since cassette control is no longer necessary on the DOS computer, we have used PB5 of the 6532 on the basic PCB of the Junior Computer as the BUSY input. Relay Re2 on the Junior interface PCB can thus be discarded. The green LED (D5) can continue to be used as a transmit data indicator.

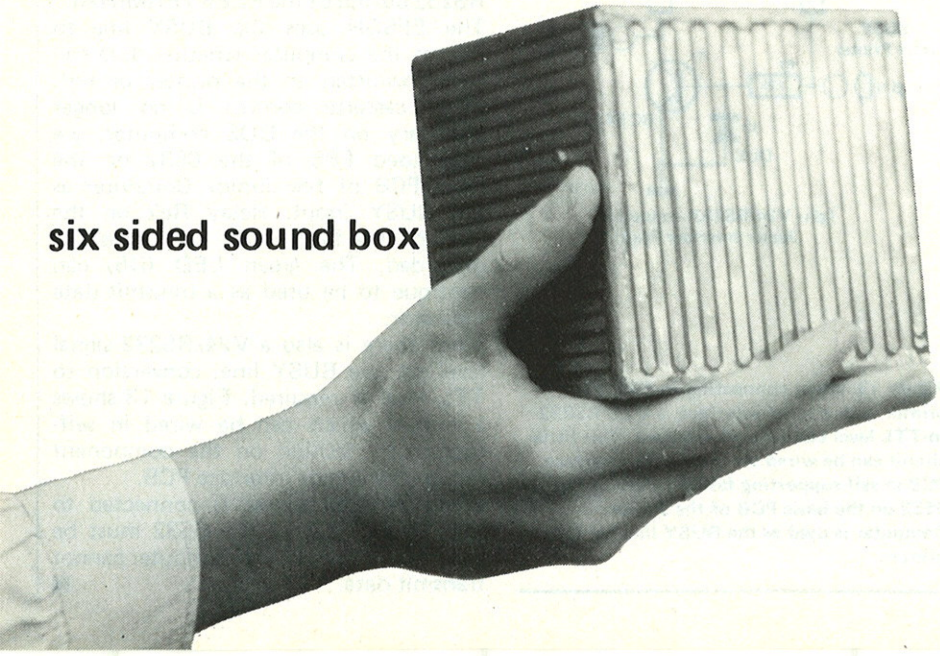
Since there is also a V24/RS232 signal level on the BUSY line, conversion to TTL level is required. Figure 13 shows a circuit which can be wired in self-supporting fashion on the component side of the Junior interface PCB.

If no EPSON printer is connected to the Junior, PB5 of the 6532 must be grounded otherwise the computer cannot transmit data. ◄

K. Siol

cubular bell

Cubes are attractive to the human mind, a fact well proved by the pyramids and the popularity of Rubiks cube. The cube described here contains an electronic 'bell' with a tone that is dependant on how the cube is picked up. Each face of the cube has a touch switch on its surface and contact with one or more of these will cause the cube to produce a sound. However, the sound will vary depending on how many and which of the faces are touched. The Cubular Bell is quite fascinating to all ages and, once picked up, becomes very difficult to put down.



six sided sound box

To answer the first question, what have the pyramids got to do with cubes? It came to pass that El Pharina, a well known tomb designer of that era, was attempting to revolutionise the current tomb designs of the period for a wealthy and influential customer. On the way to the office one morning he happened to stub his toe on a gold inlayed ebony block that was used to keep his garage door open (hence the origin of base-over-apex doors, better known lately as up-and-over). He thus hit upon the idea of using a cube as the basis for his next tomb. It was duly constructed in the grand manner. However, the foundations were contracted to an outside construction company and this is where the troubles began. The dead weight of the gigantic tomb cube was far greater than the foundations could stand and the tomb toppled over at an angle of 45°. Pharina sued of course, putting the mining company out of business. The disaster became known locally as Pharina's yonder ruination of Achmed Mining in the desert, or 'pyramid' for short. All was not lost however, since all the other tomb designers adopted the resultant shape as the state of the art thus creating numerous legends and tall stories, of which, this is one!

History will probably show that Rubik has done more for todays cube than all the other ancients put together and it is entirely possible that our Cubular Bell will not reach the same degree of fame. However, it is musical and therefore not really in the same class. That is not to say that it is a musical instrument, more a musical game. In effect, the cube will produce a tone whenever a side is touched. Each side has its own individual tone but this will be changed if two or more sides are touched at the same time, when picking it up for instance. Replacing the cube on the table will immediately silence it.

This could all work out to be a very complex circuit but a glance at the circuit diagram will show this not to be the case. It will be obvious that the heart of the circuit must be an oscillator and this is formed by the two inverters N7 and N8. The timing components of the oscillator are capacitor C1 and the resistor chain consisting of R7 to R13. Six electronic switches (ES1 to ES6) placed across the resistors are controlled from a touch plate in each face of the cube. If touch switch S1 is bridged by a finger then ES1 will be activated effectively taking R8 out of circuit. The frequency of the oscillator is determined by the total value of the resistors that are in circuit. Which face operates which electronic switch is left up to the constructor, some combinations may be better than others.

The output of the oscillator is fed via a buffer, N9, to our 'audio stage', transistor T1 and the speaker. The type of speaker used is not critical providing it is 8 Ω. The available space will probably be the determining factor!

The one essential point of the cube is that all the faces appear to be identical in order that its orientation remains a mystery. This causes a major problem when a on/off switch is to be fitted. To overcome this we have included an electronic power switch consisting of gates N10 and N11 together with ES7. Briefly, if no touch switch (S1 to S6) is bridged the electronic switch ES7 becomes open circuit thus switching off the oscillator. The use of CMOS ICs ensure that power consumption is kept to a very low level therefore the 9 volt battery should last for quite a time.

Construction

Manufacturing a cube is on a par with making four chair legs independantly — only three legs will ever touch the ground at any one time. Murphy's Law definitely states that the final face of a cube will not fit its alloted space when completing the cube and you can bet your reel of solder on that! For this reason another source of cubes would be a major advantage. Toy shops for the young are a cubic paradise and should provide one or two ideas. Another cube to check out are the 'picture cubes' from that well-

1

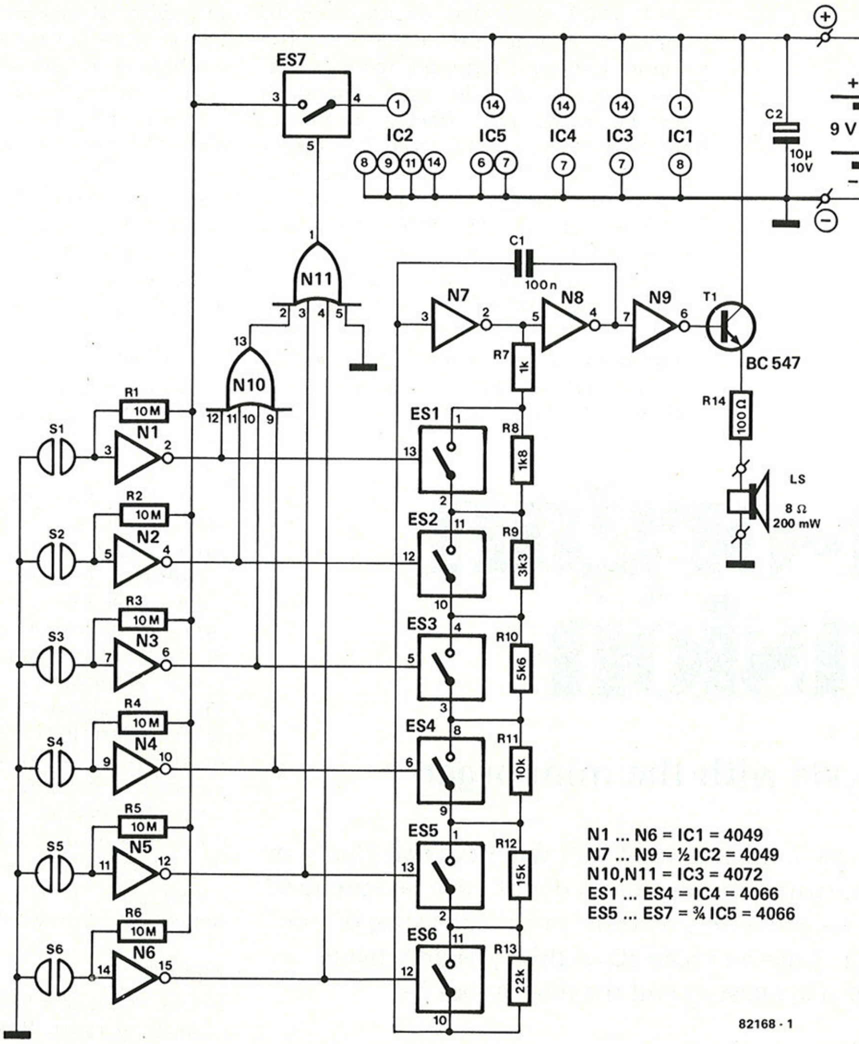


Figure 1. The circuit diagram of the Cubular Bell. The battery will last for quite a while since power consumption is very low. The touch switches can be etched on copper clad board.

known High Street store that don't, in fact, sell footwear. It is well worth shopping around for ideas before aquiring your cube because a good cube is an anonymous cube and very few fit into this category. Bear in mind that each face of the cube must contain a touch switch in one form or another. Figure 2 illustrates how this can be achieved by means of a printed circuit type of switch. If these can be made and fitted onto each face of your selected cube your problems are almost over.

The final problem is that of getting the circuit, the speaker and the battery inside the cube — we have to leave that one with you! Don't forget to make some holes in each face to let the sound out or you will have a mute cube on your hands.

Two points that may make for a more appealing cube. The sensitivity of the touch switches can be increased by raising the values of resistors R1 to R6 to about 22 MΩ. Finally, the tone range can be varied by changing the value of C1 to taste.

Now, if you can get your cube to stand unsupported on one corner, just let us know how ....

2

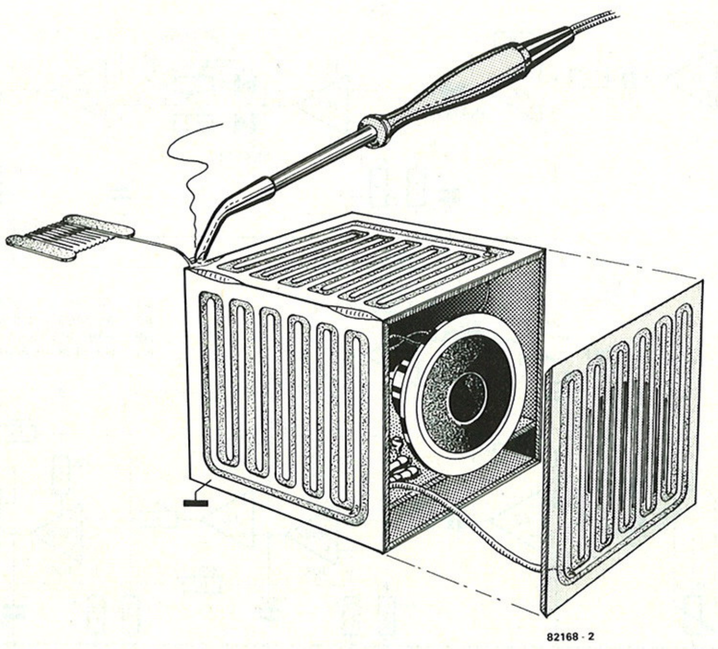


Figure 2. This illustrates one method of making your own cube if a ready made cube is not available. Care is needed if good results are to be achieved.

mini-organ extension

synthesized sounds with the mini-organ

Those of you who built the mini-organ last year will have had plenty of time to practise on the instrument and will no doubt have far surpassed its capabilities. The mini-organ is an electronic organ consisting of one single IC and a keyboard. Since an organ IC of this type only has a limited number of terminals, registers and the like cannot be incorporated.
The extension presented here, however, brings the mini-organ half-way to being a synthesizer.

The heart of the mini-organ is the SAA 1900 integrated circuit. This IC contains almost the complete electronic circuitry required for an electronic organ. All 56 key contacts of the keyboard are directly connected to the IC via a 7 x 8 matrix. This means that 15 IC pins are already assigned. 4 pins are needed for the audio-frequency outputs, 2 pins for the power supply, 1 pin as a clock input, one more pin as a modulation input and, finally, a pin for the mode. The total is 24 pins which is the full extent of the IC's terminals. It offers full polyphonic performance and good sound, but that is all. This extension changes the whole picture. The extension consists of a VCF with attack and decay generator. These three terms will be familiar to synthesizer enthusiasts, but there is a brief explanation for strangers to the field: a VCF is a voltage controlled filter. "Attack" is the phase in which the note of a musical instrument increases in volume or tone from zero to its maximum value. In the decay phase this value drops from its maximum to a particular level, whilst the key remains pressed.

The VCF

To avoid having to employ expensive, special ICs as in the polyphonic synthesizer, the VCF was designed to a well-proven and well-known format. It is a lowpass filter with a skirt of 18 dB/octave. Three active lowpass filters, each with 6 dB/octave, are connected in series to achieve this filter characteristic. Each of these filters consists of an OTA (CA 3080 in figure 1), a capacitor and an operational amplifier as an output buffer. The control current at pin 5 of each OTA determines the basic frequency of the filter, when combined with the capacitor (e.g. C9 in figure 1). These control currents are supplied from a current source, consisting of A11 and T1, which is also controlled. The basic frequency of the entire filter thus depends on the setting of P11.

Attack!

Purely manual adjustment of the basic frequency (with P11) is not sufficient. An organ note filtered in this way still sounds too much like an organ!. What is needed is an attack/decay generator.
This type of generator makes the filter

1

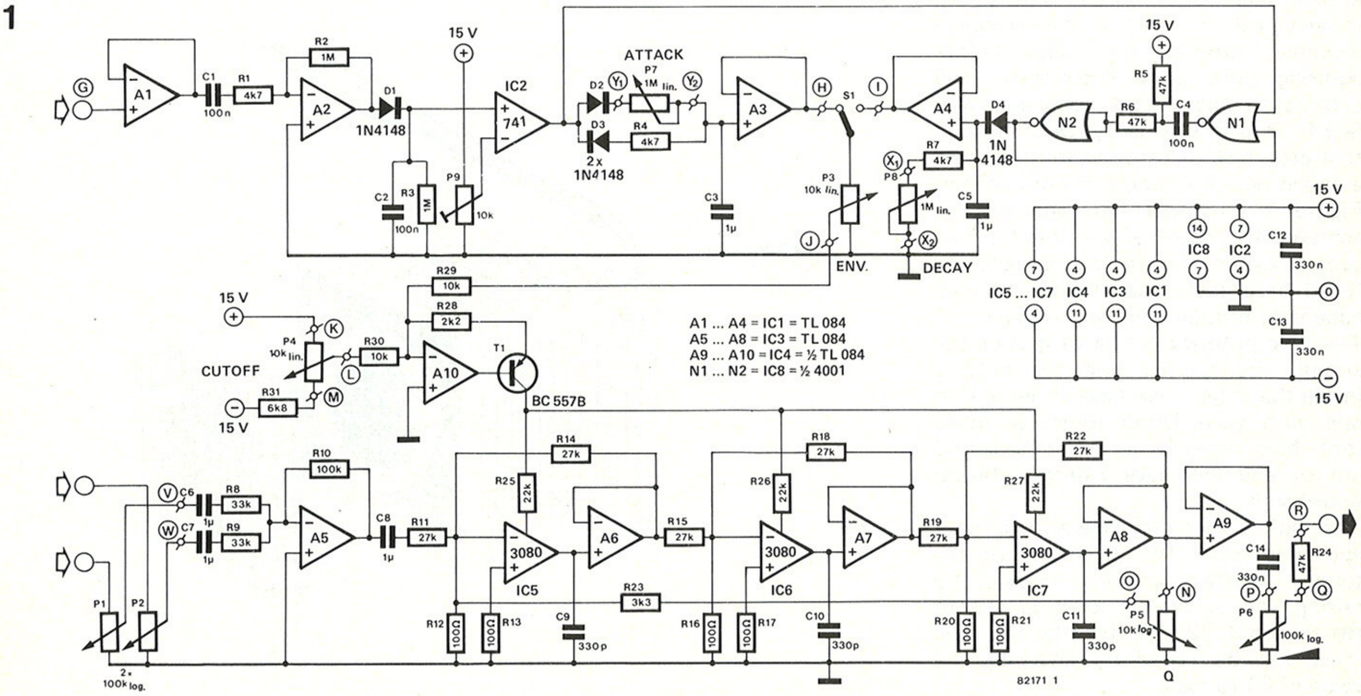


Figure 1. The circuit diagram of the extension. 8 integrated circuits are used to produce an attack/decay generator and a voltage-controlled lowpass filter with a skirt of 18 dB/octave.

2

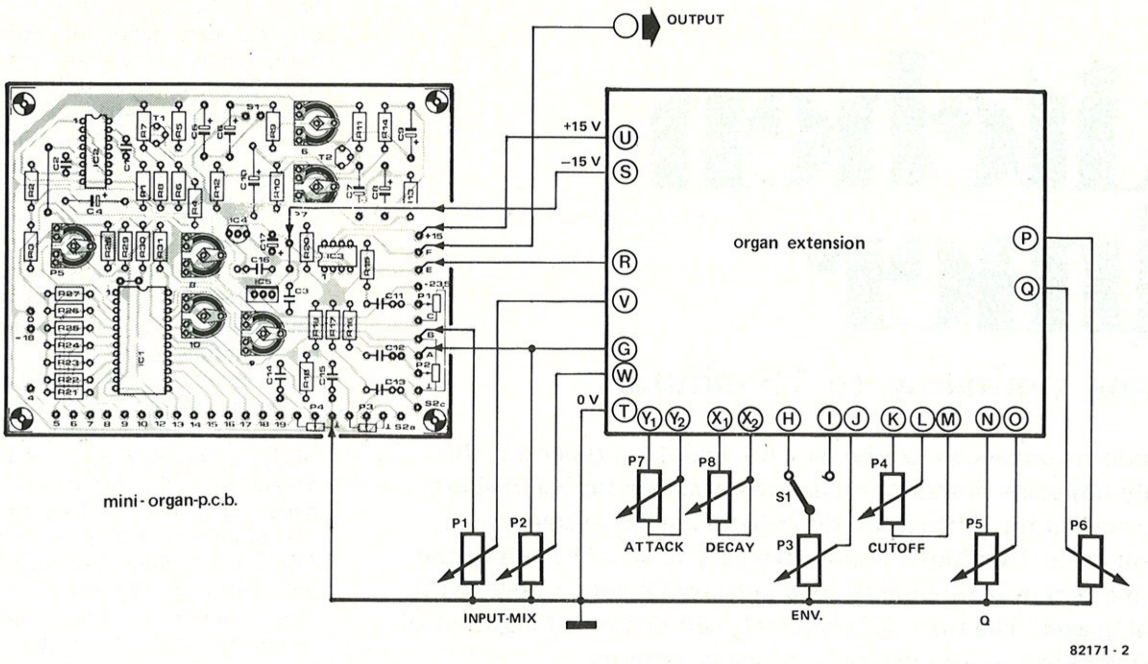


Figure 2. Wiring diagram of the extension. Connections to the organ printed circuit board and terminals for the controls (such as potentiometers and switches) are designated with the same letters as in the circuit diagram.

attack-dependent and opens the way to many possibilities in sound experimentation.

The status of a key, i.e. whether it is pressed or not, unfortunately cannot be indicated by the keys themselves. This would require a second row of contacts and would be very expensive. However, there is another inexpensive method: if the organ is emitting a note, a key must be pressed. It is therefore only necessary to know that a note is present.

This task is performed by A1 . . . A3. A1 picks off the note at a high impedance at terminal A of the organ PCB. A2 amplifies this buffered signal by a factor of 200, i.e. it limits it. D1 and D2 produce a positive DC voltage from the limited square-wave and, based on the level of this voltage, comparator A3 decides whether a note is present or not. D2, P7, C3 and A4 form the attack section. If a key is pressed the voltage at the output of A3 jumps to + and C3 charges up, depending on the setting of P7. At the end of a keystroke C3 is discharged over R4 and D3.

The voltage jump of A3 triggers the monostable consisting of N1 whose output pulse charges C5 very rapidly. P8 determines the discharge time of C5. This decay voltage is now buffered by A5. Either an attack or decay voltage can be applied to the control current source by means of S1. P3 determines the modulation depth.

Parts list

Resistors:

R1,R4,R7 = 4k7
R2,R3 = 1 M
R5,R6,R24 = 47 k
R8,R9 = 33 k
R10 = 100 k
R11,R14,R15,R18,R19,R22 = 27 k
R12,R13,R16,R17,R20,R21 = 100 Ω
R23 = 3ks
R25 . . . R27 = 22 k
R28 = 2k2
R29,R30 = 10 k
R31 = 6k8
P1,P2,P6 = 100-k-pot. log.
P3 . . . P5,P9 = 10-k-pot. lin.
P7,P8 = 1-M-pot. lin.

Capacitors:

C1,C2,C4 = 100 n
C3,C5 . . . C8 = 1 µ foil type
C9 . . . C11 = 330 p
C12 . . . C14 = 330 n

Semiconductors:

D1 . . . D4 = 1N4148
T1 = BC 557B
IC1,IC3,IC4 = TL 084
IC2 = 741
IC5 . . . IC7 = CA 3080
IC8 = 4001

Additionally:

S1 = single-pole changeover switch

Sounds

At point A on the organ PCB, the mini-organ delivers an asymmetrical square-wave signal which is rich in harmonics. This signal serves two purposes: firstly, it triggers the attack/decay generator; secondly, it is applied via P2 as the signal intended for filtering. The signal from point B of the organ PCB, which is one octave lower, can be mixed in by means of P1.

Depending on the Q of the filter adjusted with P5, sounds can be produced which vary from very dull to very bright. Furthermore, P5 can be used to make the filter oscillate. The result is a sinewave oscillator with which widely varying sound effects can be generated via the attack/decay generator and any key of the upper part of the keyboard.

If S2 is in the attack position, P3 and P4 can be adjusted to obtain a sound reminiscent of brass instruments. In the decay position, a piano-like sound can be produced.

Since the output of the filter is fed back to the output stage of the joy-organ, the unfiltered signals can be added to the filtered signals by mixing. The phase shift of the filter produces a phaser-like sound, by eleminating individual, narrow frequency ranges.

Construction and connection

The entire extension circuit can be built on Vero board. It requires some care in construction because 8 ICs and some passive components need to be mounted.

The terminals of each control are identified with letters which also appear in the wiring diagram (figure 2). The power supply for the extension is obtained at the appropriate points on the organ printed circuit board. The only output missing is for the – 15 V and this must therefore be picked off the wire link between C17 and R20 on the organ printed circuit board. S2 of the mini-organ is discarded. Instead, points S2a and S2c are connected with a wire link.

As a general precaution, signal lines should not be too long nor be arranged in the vicinity of the mains transformer.

kitchen timer

accurate timing up to 15 minutes

Most modern cookers are equipped with a cooking timer but this invariably has some limitations when the accurate timing of short periods is called for. The circuit described here has excellent resolution up to 15 minutes and is very easy to set. The end of the preset time period is announced by an electronic gong rather than the usual buzzer. The timer is completely self-contained and is ideal for short cooking periods where accuracy is required.

M.R. Brett

The two most critical parameters in cooking are expertise and timing. We have to admit that our knowledge of the first (and foremost) requirement could be written on the outside of a 2716. However, the second point is a different kettle of fish. If electronics is good at anything at all it surely must be period timing. The circuit here allows four independant time periods to be preprogrammed and selected when required. A further asset of the circuit is the absence of any display that requires watching. The end of the time period is given by an audible 'gong'.

The circuit diagram shown in figure 1 can be broken down into four main parts, the counter (IC1), a comparator (IC2), a memory (IC3) and the sound generator (IC4). The presetting of time periods is carried out by means of the 16 switches at the right of the diagram. The use of quad DIL switches would be ideal for this purpose.

The function of the circuit is fairly straightforward. With the circuit in the quiescient state the $\overline{Q2}$ output of FF2 will be at logic 1 thus the counter IC1 will be inhibited via the reset input. Its outputs will be held low. The A=B output of the compara-

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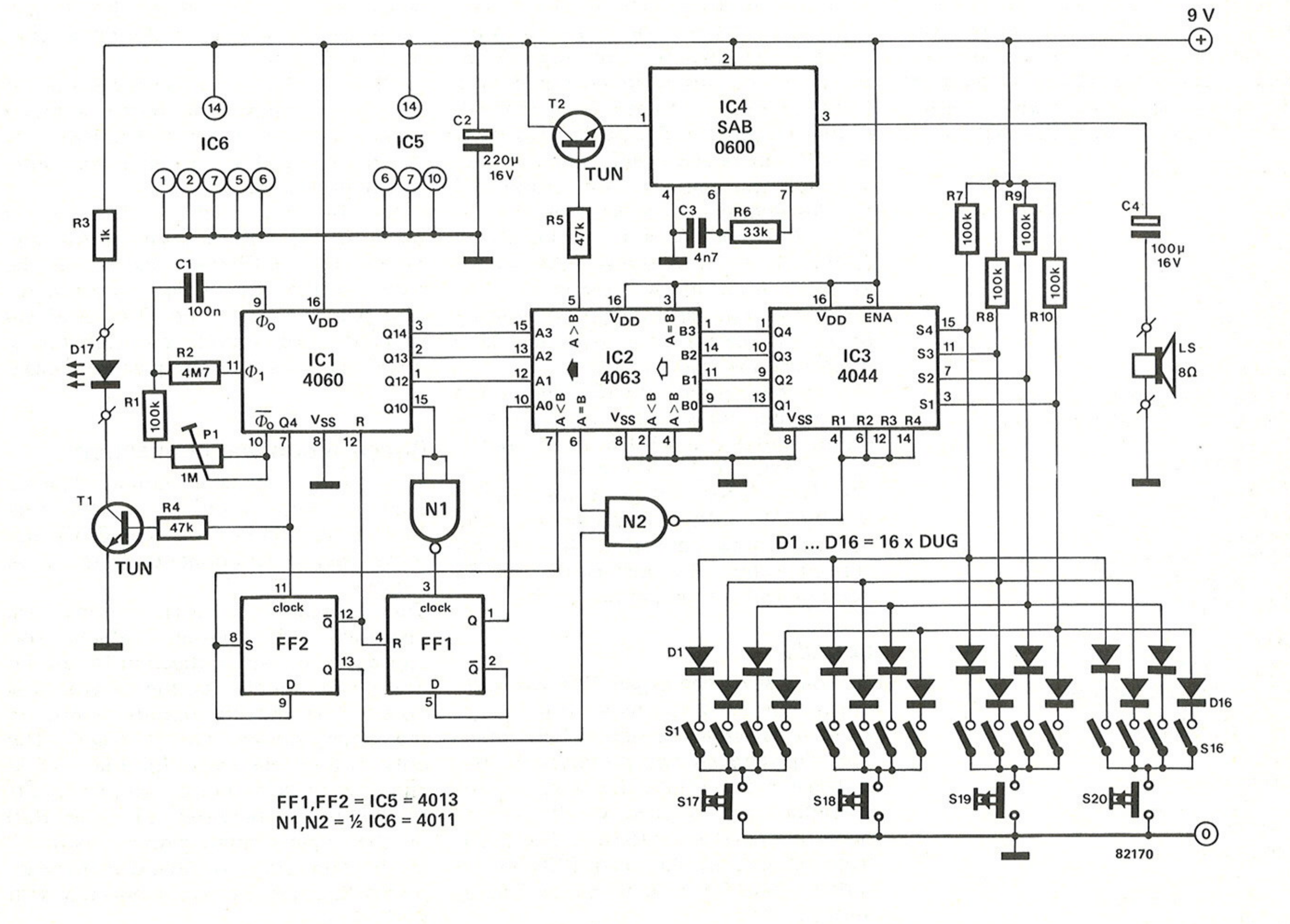


Figure 1. The circuit diagram of the timer consists of four basic parts: the counter IC1, the comparator IC2, the memory IC3 and the sound generator IC4.

tor (IC2) will also be low and the memory (IC3) will receive a reset pulse via the gate N2. The comparator is now ready to accept data relative to the required preset time period. This is preset in BCD format on one set of four switches of S1 to S16. Once selected, the time code is entered into the memory by pressing the relative switch from S17 to S20.

There is now data in the memory and this is presented to the comparator causing the A<B output to change to logic 1. The flipflop FF2 will flip (or is it flop?) which will allow the counter to begin to do its job. This is a very useful IC in that it also includes an oscillator and this is used to provide the clock frequency for the timer. The frequency is determined by the RC network consisting of C1, R1, R2 and preset P1. The latter is included to allow for fine tuning of the oscillator frequency if it is required.

When the reset level is removed from pin 12 of IC1 the counter is enabled and its outputs will count up from 0 at the clock frequency. The Q4 output of the counter is used switch the LED on via transistor T1 as a reminder that the timer is in operation.

The counter will continue doing just that until the A=B output of IC2 goes high, this will occur when the counter output equals the memory. A number of events will now happen. A logic 0 reset pulse will reach IC3 (via N2) and the memory will be cleared. The output of the memory, and therefore the B inputs of the comparator, will all be at logic 0 and, because the count still exists on the A inputs of the comparator, the A>B output will revert to logic 1. This will provide a pulse via T2 to the sound generator, IC4, and the gong will sound to signal the end of the time period.

By this time of course, the A<B output of IC3 will have returned to zero (the A inputs of the comparator are no longer less than the B inputs) allowing FF2 to change state on the next incoming clock pulse from the counter. When this arrives the counter will be reset to zero (the $\overline{Q}$ will go to logic 1) and we are back where we started, waiting for the next time period to be entered via one of the switches S17 to S20.

Although the circuit is rather more complex than the usual 555 based timer circuits it does provide the very useful possibility of a number of preset time periods. The circuit diagram shows four but more are possible if needed. Simply add another switch (S21 for instance) and four more diodes.

The power comsumption of the circuit is low at about 3 mA and the 9 volt battery will last for a good many eggs.

It will be obvious that the applications for this particular timer do not necessarily have to end in the kitchen. It is versatile enough to find a great many uses wherever accurate timing is needed ◀

market

Multi-channel analyser

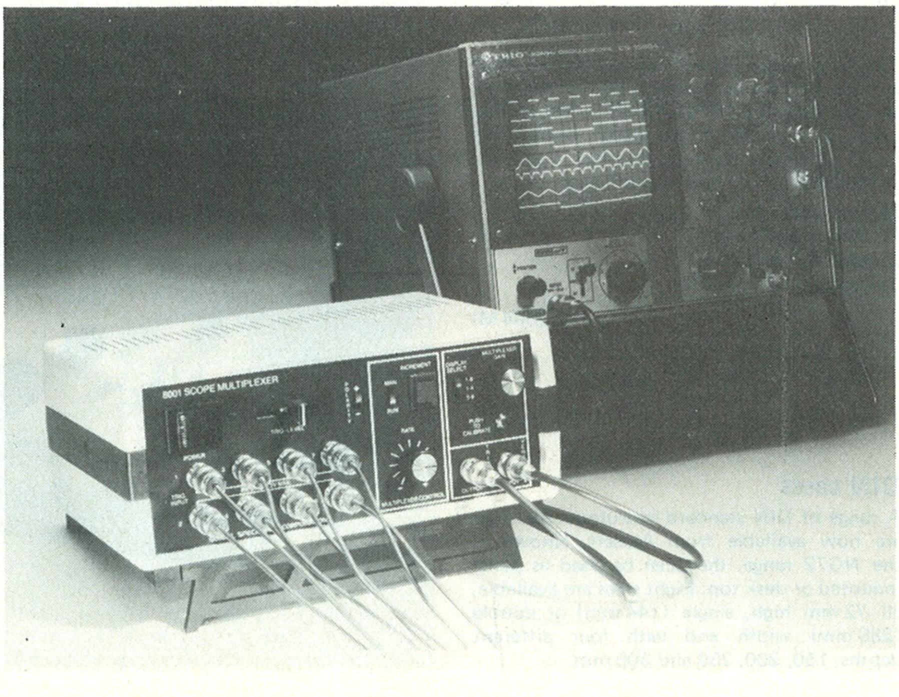
A multiplexing device which converts a general-purpose single- or dual-channel oscilloscope into an eight-channel instrument has been developed by GSC. The new model 8001 multiplexer, which functions in the same way as a simple logic analyser minus its memory, and allows simultaneous events on different channels to be compared and displayed in direct relationship to one another.

The instrument allows oscilloscope users to view events occurring synchronously or asynchronously, and the user can observe all eight channels at once or one of two 4-channel combinations. Once the overall signal relationships have been observed, the operator can 'zero in' on a single channel by placing the multiplexer in the manual mode and incrementing the display to the desired channel.

Input to the multiplexer is via eight BNC connectors, and the instrument will accept signals of ± 5 V (10 V peak-to-peak) with frequency response which is flat to 12 MHz and 3 dB down at 20 MHz. Input impedance is 1 MΩ. Comprehensive trigger facilities are provided; the signal which is to serve as the trigger is connected to channel 1, and the trigger level can be continuously varied over the ± 5 V range with polarity switchable to positive or negative. Trigger output is a TTL level signal which is internally switch-selectable to 0.01 μs or 1 μs duration, and this is connected to the oscilloscope's external trigger input.

Global Specialties Corporation,
Shire Hill Industrial Estate,
Saffron Walden,
Essex CB11 3AQ
Telephone: 0799.21682

(2510 M)

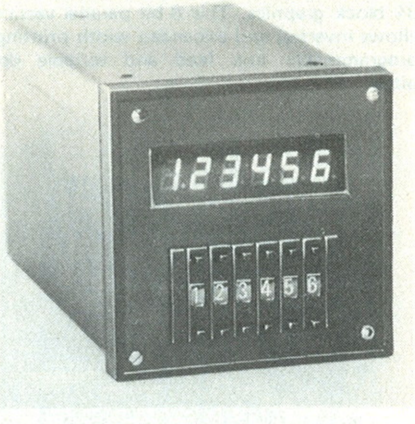


Imperial to metric counter

A big problem for many manufacturers today is the need to sell products in metres, litres or kilograms, using production machinery still fitted with instruments showing yards, gallons, pounds etc.

The solution, from Britec, is both accurate and inexpensive.

The user simply replaces the existing output indicator with one of the new Britec 'pre-scaling' counters. These can be supplied ready-programmed, to give a precise Metric display from an Imperial output, or in a programmable form which the production engineer can adjust on site. By this means, virtually any arbitrary pulse frequency can be 'converted' to give a display in the required units. Apart from metric conversions, the Britec 'pre-scaling' counter has many other applications, including for example adjustable batch counting, whereby any required number of pulses can be chosen to advance the counter by one digit.



5 or 6 digit versions are available, with 'up' or 'down' counting; counting speed is up to 25,000 per second; other features include choice of panel or remote re-set, and thumbwheel batch setting.

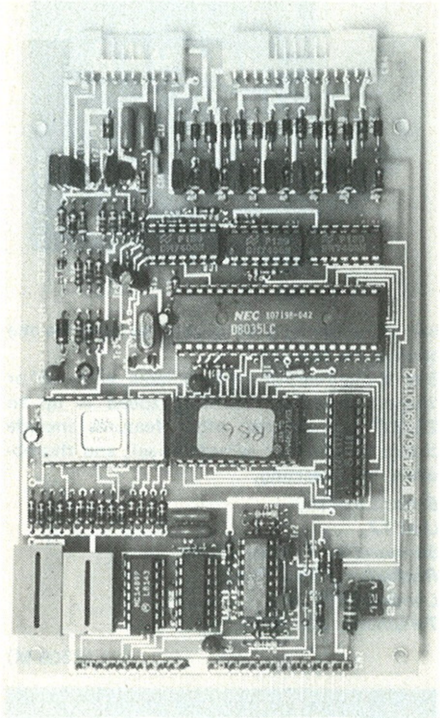
Britec Limited,
Unit 17,
Bermondsey Trading Estate,
Rotherhithe New Road,
London SE16 3LL
Telephone: 237.8081

(2506 M)

market

Interface boards

Stotron Ltd., are now able to supply a number of Parallel and Serial Interface Boards which compliment their range of needle printers from Roxburgh Printers Ltd. The compact 12 or 24 V d.c. boards have been introduced to drive 21 and 40 column DP822/824 printers according to the mechanism in use. Both versions offer a full 96 ASCII character set and the Parallel versions have 64 symbols and European characters, and 64 block graphics. This 8 bit parallel version allows inverted and expanded width printing, programmable line feed and variable dot pitch.



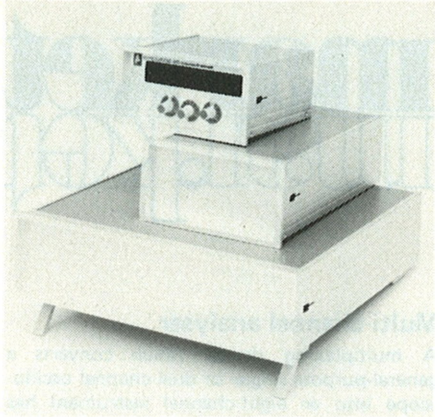
The Serial versions also offer several special symbols, including £ sign, and the character set is stored in a 2716 EPROM to allow alteration if required. These Serial boards also have 20 mA current loop facilities, baud rate (110-4800), parity and stop bit selection.

Stotron Ltd.,
72 Blackheath Road,
London SE10 8DA
Telephone: 01.691.2031

(2504 M)

DIN cases

A range of DIN standard instrument housings are now available from Alusett. Known as the NG72 range, they can be used as panel mounted or desk top. Eight sizes are available, all 72 mm high, single (144 mm) or double (288 mm) width and with four different depths, 150, 200, 250 and 300 mm.



The housings are supplied in kit form including all necessary mounting materials. They are easily assembled with only 10 screws. The housing frame consists of rigid distortion resistant aluminium profiles anodised in natural colours. Top and base cover plates are made of superior quality coated aluminium in a grey-blue colour featuring a fine leather grain surface. Feet can be attached to the base cover plate if the housing is to be used as a free standing or desk top instrument.

Alusett UK Limited,
Whiteshute House,
Whiteshute Lane,
Winchester,
Hampshire SO23 9RA
Telephone: 0962.68673

(2501 M)

Sweep Function Generator

The 12 MHz Sweep Function Generator SFG611 is a high performance instrument offering several versatile facilities which simplify many test measurements in the 0.01 Hz to 12 MHz frequency range. The pushbutton-selected waveforms, sine, square or triangular, are available at levels up to 10 V pk-pk open circuit from 50 Ω. The continuous amplitude control, in conjunction with two fixed attenuators of x0.1 each, give a suitable range of output level control. A d.c. offset facility, adjustable from −5 V through 0 to +5 V, gives a unipolar capability with all combinations of signal and offset free of clipping.
The mark/space ratio of all the waveforms can be varied by a continuous control in conjunction with three switch positions. This offers: a) fixed mark with variable space, continuously adjustable from 1:1 to 1':19; b) continuously adjustable mark/space ratio from 19:1 through 1:1 to 1:19 at a fixed frequency of approximately x0.1 main frequency setting; c) variable mark with fixed space, continuously adjustable from 1:1 to 19:1. The comprehensive sweep facilities can be used in either logarithmic or linear mode, covering the need for overall frequency response or particular narrow-band measurements on 465 kHz or 10.7 MHz. IF circuits, for example.
Internal or external sweep (VCF) can be selected by means of a slide switch. The internal sweep generator is continuously adjustable from 50 Hz to 0.001 Hz by means of a single logarithmic control. A triangular frequency sweep enables both directions of the sweep to be displayed, and an associated auxiliary output is provided for driving the oscilloscope timebase. Also incorporated is a 'single-shot' sweep facility, enabling the SFG611 to be used with X-Y recorders, the TTL squarewave output then operates as a pen lift control.

Marketing Services Dept.,
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Crowborough,
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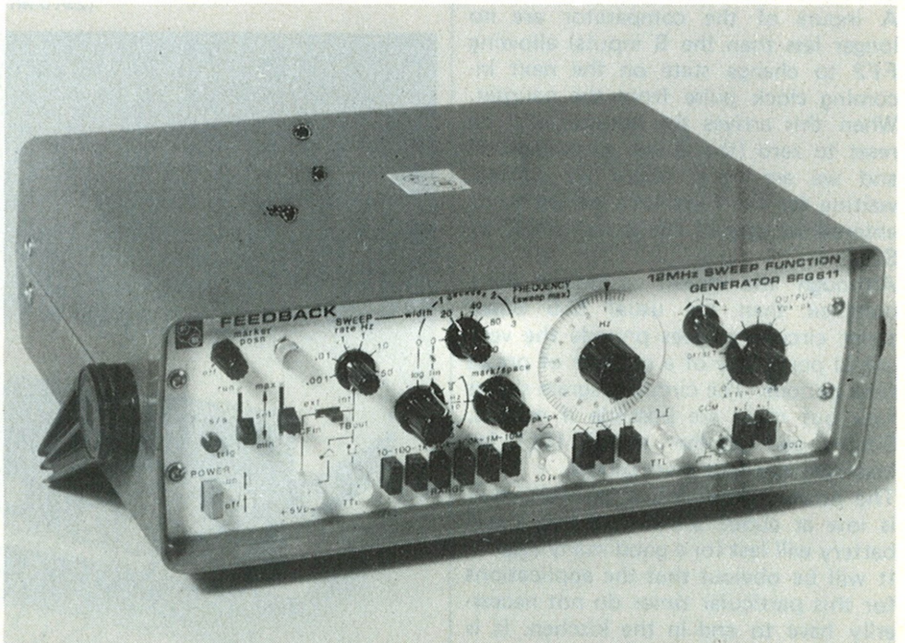
Telephone: 08926.3322

(2503 M)

market



elektor switchboard

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November

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E12

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33/35V	17p
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2.2/35V	22p
3.3/35V	22p
4.7/16V	22p
4.7/35V	24p
6.8/25V	26p
6.8/35V	25p
10/16V	25p
10/35V	34p
15/10V	22p
15/16V	30p
15/25V	32p
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10nF	12p
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22nF	18p
47nF	32p
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99p each

160V Polystyrene Caps 5% or better

10pF, 15pF, 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF, 180pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1nF, 1.5nF, 2.2nF, 3.3nF, 4.7nF, 10nF

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150nF, 220nF	11p
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2.5 × 5	80p
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3.75 × 5	93p
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60% Solution

250ml bottle £1.60

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uFd	V	
47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	90p

Beautiful Mini Radial Low Voltage

Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

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50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K

99p each

1000vdc Caps (300VAC) Axial

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4.7nF, 6.8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

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3.3nF, 4.7nF	32p

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100nF 20% 76p

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100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p/4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

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10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	66p

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125gms

18 swg	2.95
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Pins	Lo-prof	W.Wp.
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14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	–
22	22 p	–
24	24 p	70 p
28	28 p	79 p
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2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	98p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055CSF	60p
2N3055RCA	80p
2N3107	46p
2N3108	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N2393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442MOT	2.40
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
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2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
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2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
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2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
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2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5366	25p
2N5367	28p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
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2N5451	25p
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2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

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2N5654	35p
2N5786	80p
2N5813	23p
2N6027	30p
2N6030	6.60
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2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
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2SC2078	1.70
2SJ49	3.98
2SJ82	3.98
2SK134	3.98
2SK226	3.98
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40250	95p
40251	2.77
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40264	2.63
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
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AC128	25p
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AC152	45p
AC153	55p
AC153K	64p
AC176	27p
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AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
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AF178	88p
AF200	65p
AF201	75p
AF239	1.24
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AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
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BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
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BC115	22p
BC116	32p
BC116A	37p
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BC118	19p
BC119	38p
BC121	82p
BC123	82p
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BC149B	12p
BC149C	13p
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BC159B	13p
BC159C	18p
BC160	42p
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BC560	32p
BC560C	34p
BC727	44p
BC737	44p
BCW32R	60p
BCY30	1.15
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
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BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
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BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
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BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
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BF123	70p
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BF161	58p
BF163	50p
BF166	57p
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BF170	79p
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BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
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BF246	52p
BF246A	
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BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
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BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
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BFR81	25p
BFR90	2.11
BFS28	2.95
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BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
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BFW90	1.53
BFX12	1.00
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BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
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BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
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BFY50	23p
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BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
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BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
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BSX39	80p
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BSX76	50p
BSX77	55p
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BSY39	47p
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BSY95A	25p
BU104	2.22
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BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY18S	3.95
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
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ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
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ME6001	25p
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ME9001	56p
ME9002	56p
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MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
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MJ2955	1.00
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MJ4502	3.99
MJE340	53p
MJE370	97p
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MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
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MJE3055	69p
MP8111	1.00
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MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
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MPS4356	60p
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MPSA10	28p
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MPSA70	45p
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MPSA93	39p
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MPSU05	55p
MPSU06	56p
MPSU07	75p
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MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
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NKT239	44p
NKT240	42p
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NKT244	40p
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NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

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Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel. **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more . . . .
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TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
	TIC106D	59p
	TIC106M	68p
8A	TIC116A	66p
	TIC116B	68p
	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
12A	TIC126A	72p
	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THRISTORS

1.2 amp plastic	
Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12
4.7 amp plastic	
Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2.00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

BRIDGE RECTIFIERS
(PIV shown in brackets)

1 amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietory Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES

400-500 mW E24 Series 2.4-47 V	8p
1.3 Watt E24 Series 3.3-82 V	15p
2.5 Watt E24 Series 7.5-75V	1.10
5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V	1.25
10W Pos. Stud Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110	1.25
20W Pos. Stud (BZY93 series) E24 values 7V5-75V	2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2.47
BPX29	2.47
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	10p
LD36A	12p
LD37A	12p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2.65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2.25
TIL66	2.30
TIL67	2.35
TIL78	60p
TIL81	1.60
TIL99	1.35
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright see next column.

POWERFET AMP MODULES FROM PANTECHNIC

now available from LONDON. Send s.a.e. for specs.

PFA 100	16.00
PFA 200	22.55
10,000 mF 80 V	4.10

D. CONNECTORS 25 WAY

Solder type	
Male	1.60
Fmale	2.05
Angled PCB	
Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES

New LEDs
Now in stock
R = red
G = green
Y = yellow

Large diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p
Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat		
RGY8	83p	78p

LINEAR ICs

AN103	2.20
AY1-0212	6.60
AY3-0215	7.95
AY1-1320	2.20
AY1-5050	95p
AY1-1270	7.26
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 — See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 — See 78XX Series Volt Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50
LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303= LM1303N	
MC1304= LM1304N	
MC1305= LM1305N	
MC1307= LM1307N	
MC1310= LM13010N	
MC1330= LM1330N	
MC1352	1.75
MC1456	1.80
MC1458= LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496= LM1496	
MC3340	1.45
MC3401= LM3401	
MC3403= LM3403	
MC3405= LM3405	
NE531N	1.36
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE562	4.09
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
PLL02A	4.95
PLL03A	12.75
RCA136	59p
S566B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N= SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs
CPUs

1802	7.00
2650A	11.99
6502	3.24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21.00
SCMP1	17.66
Z80A	2.96

MEMORIES

1702A	3.50
2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	80p
2532	3.60
2708	2.25
2716 (5v)	2.11
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs including COMPUTER SUPPORT

ADC0800	22.50
ADC0816	14.90
ADC0817	10.06
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULB2003A	85p
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.42
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	1.10
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8259	4.00
8279	4.40
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9062	2.50
Z80ACTC	2.65
Z80ADART	8.00
Z80ADMA	10.00
Z80APIO	2.80
ZN425E8	3.39
ZN426E8	3.39
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS
(See also Linear ICs)

— Positive —	
100 mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100 mA TO5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500 mA TO202	
7805M	47p
7812M	47p
7815M	47p
7842M	47p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39
— Negative —	
100 mA TO92	
79L05	59p
79L12	59p
79L15	59p
500 mA TO202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp. TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99
— Variable —	
L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
LM337K	4.60
LM337MP	1.73
LM337T	1.75
LM345K	3.60
LM350K	4.50
LM396K	13.52

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TO18 (BC109)	18p
TO220 (TIP29)	36p

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1.008MHz	2.74
2.00MHz	2.24
2.097152MHz	3.50
3.2768MHz	1.50
4.00MHz	3.00
4.194394MHz	2.00
4.433619MHz	1.10
5.00MHz	1.75
6.00MHz	1.50
6.9375MHz	3.50
8.00MHz	1.75
10.00MHz	1.75
18.00MHz	1.99
20.00MHz	1.99
27.648MHz	2.60
48.00MHz	1.75
100.00MHz	5.50
5.5 MHz Ceramic filter	90p

VALVES

DY86/87/802	1.32
ECC82	1.22
ECC83	1.22
ECC84	1.22
EF86	1.80
EL34	2.89
EL84	2.50
KT66	10.75
KT88	12.50
PC900	1.76
PCC84	3.00
PCC85	3.40
PCC89	1.89
PCF86	2.30
PCF201	3.00
PCF801	2.67
PCF802	2.11
PCL82	1.80
PCL85	2.20
PCL86	2.10
PCL805	2.20
PD510	4.95
PFL200	2.99
PL504	2.11
PL508	2.36
PL509	4.75
PL802	4.17
PY88	1.62
PY500A	2.63
6L6	2.59

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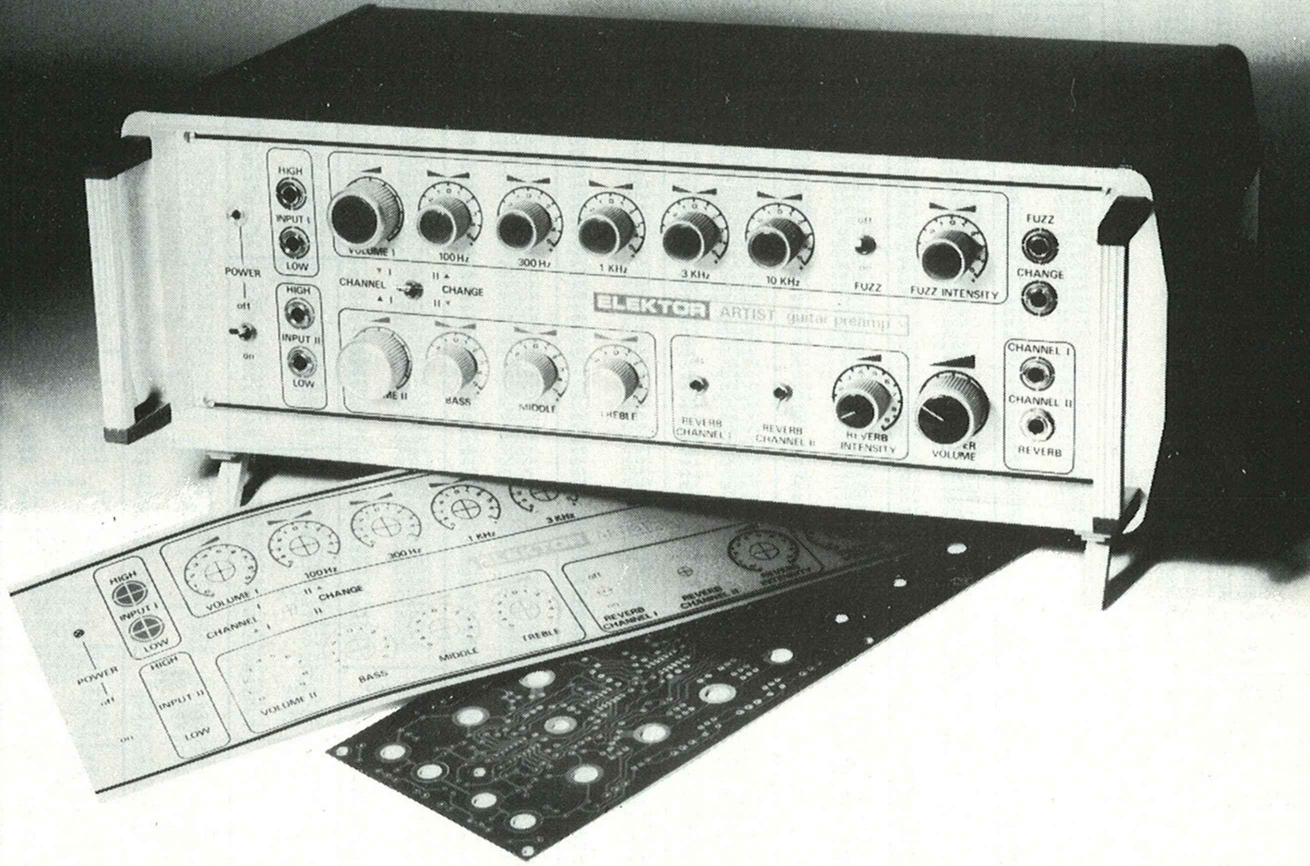

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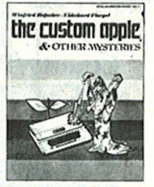

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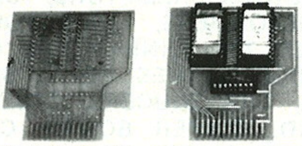

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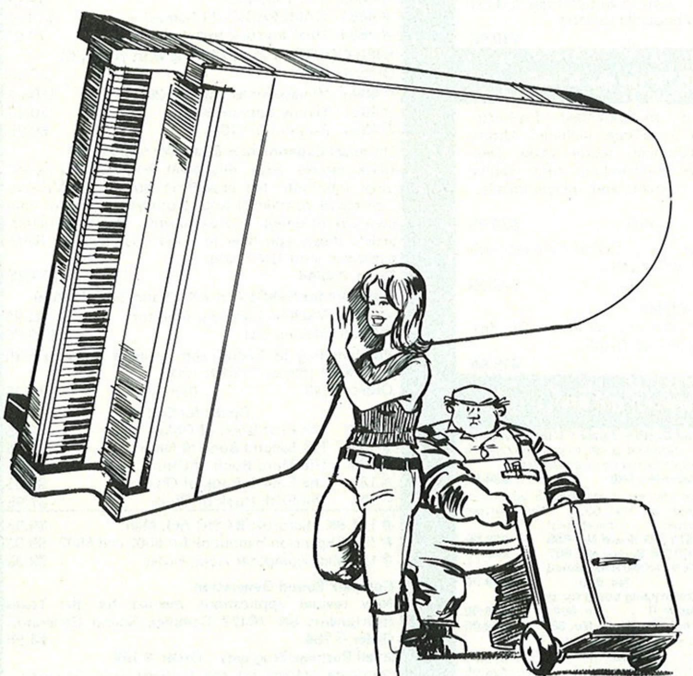

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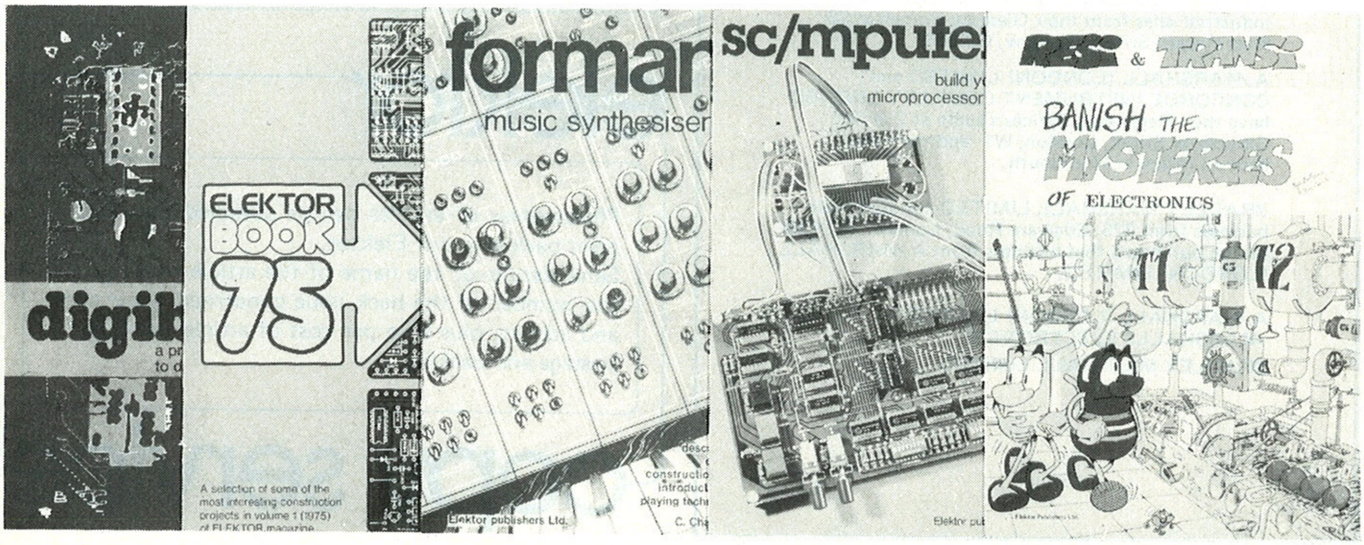

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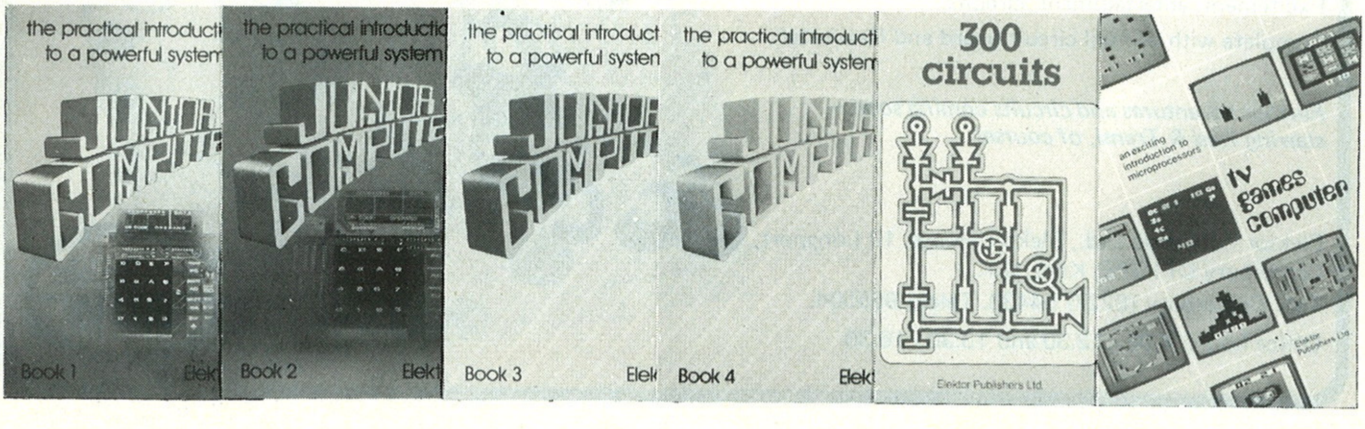

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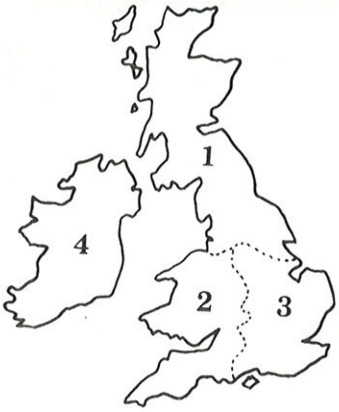

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Example:

digisplay	(E13)	9376	3.25	7.25
1	2	3	4	5

1. Circuit title
2. reference to associated article(s)
3. board number

U.K.:

4. price (in £) inclusive of 15% VAT

U.S.A. and Canada:

5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
formant (E25 . . . E30):			
VCO	9723-1	9.90	23.50
experimenting with the SC/MP:			
RAM-I/O	9846-1	6.90	16.50
SC/MP board	9846-2	2.60	6.—
E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32):			
ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31, E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	4.35	10.50
experimenting with the SC/MP (E31 . . . E33):			
HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
4 k RAM card	9885	14.70	35.—
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
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E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
touch dimmer	78065	1.30	3.—
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E41: SEPTEMBER 1978			
formant			
24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
resonance filter module	9951	4.45	10.50
VHF/UHF modulator	9967	1.55	4.—
E43: NOVEMBER 1978			
ASCII keyboard	9965	7.70	18.50
E44: DECEMBER 1978			
elekterminal	9966	7.50	18.—
E48: APRIL 1979			
TV games computer:			
UHF/VHF modulator (see E42, October 1978)	9967	1.55	4.—
main board and documentation	79073	19.95	47.50
power supply	79073-1	2.45	6.—
keyboard p.c.b.	79073-2	3.65	8.50
Complete set of four boards (9967, 79073, 79073-1, 79073-2), documentation and one ESS software record (ESS 006):		26.25	62.50
E49: MAY 1979			
Interface for μPs	79101	1.40	3.50
E50: JUNE 1979			
stereo decoder	79082	2.40	5.50
E53: SEPTEMBER 1979			
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filter section	9897-1	1.65	4.—
tone control section	9897-2	1.65	4.—
E55: NOVEMBER 1979			
topamp	80023	1.45	3.50
E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
steam train	80019	1.90	4.50
E57: JANUARY 1980			
digital tuning scale (two boards)	80021-1/2	7.05	17.—
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talk funny (E56)	80054	1.55	3.50
E58: FEBRUARY 1980			
aerial amplifier	80022	1.85	4.50
elektor vocoder,			
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filter board	80068-3	3.45	8.—
input/output board	80068-4	3.20	7.50
supply board	80068-5	2.85	7.—
E59: MARCH 1980			
chorosynth	80060	22.15	53.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.50
transistor ignition	80084	3.90	9.50
E61: MAY 1980			
BASIC cassette interface	80050	5.60	13.50
PWM amplifier	80085	1.50	3.50
Junior computer:			
main board	80089-1	12.60	30.—
display board	80089-2	1.30	3.—
supply board	80089-3	3.—	7.—
E62: JUNE 1980			
pest pester	80130	1.10	2.50
E63/64: SUMMER CIRCUITS 1980			
STAMP amplifier	80543	1.40	3.50
PROM programmer	80556	3.85	9.—
E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.50
E67: NOVEMBER 1980			
central heating pump control	81019	2.55	6.—
fridge alarm	81024	1.45	3.50
E69: JANUARY 1981			
disco ceiling lights	81012	8.70	20.50
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main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
voiced/unvoiced detector			
detector board	81027-1	3.40	8.—
switch board	81027-2	4.05	9.50
E71: MARCH 1981			
MW receiver	81111	1.95	4.50
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2 complete modules (built and tested) + 1 main board + self-adhesive front panel	81117-1	35.70	85.—
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E72: APRIL 1981			
transistor match-maker	81123	1.75	4.—
intelekt	81124	5.65	13.50
universal power supply	81128	2.45	6.—
E74: JUNE 1981			
Junior Computer			
interface board	81033-1	19.05	45.50
−12 V supply	81033-2	1.45	3.50
adaptor board	81033-3	1.30	3.—
storage scope	81141	3.80	9.—
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E75/76: SUMMER CIRCUITS 1981			
continuity tester	81151	1.25	3.—
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E77: SEPTEMBER 1981			
TV games computer extension board	81143	19.—	45.—
disco light controller	81155	3.20	7.50
DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
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E78: OCTOBER 1981			
RF-test generator	81150	1.60	3.80
economical fridge defroster	81158	1.80	4.35
EPROM programmer	81594	1.45	3.50
wide range dark room timer	82004	2.25	5.50
shutter speed meter	82005	3.75	9.—
LCD panel meter	82011	1.65	4.—
universal LED display	82015	1.60	4.—
E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	5.35	12.50
keyboard section	82001-3	3.15	7.50
sine-wave oscillator	82006	2.10	5.—
telephone amplifier	82009	1.55	3.50
power supply	9968-5A	1.40	3.50
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metal detector	82021	5.65	13.50
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high boost	82029	1.85	4.50

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E80: DECEMBER 1981

70cm transverter (Oct.)	80133	12.50	30.—
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receiver board	82001-1	4.10	10.—
video control board	82001-4	4.25	10.—
VHF-UHF converter board	9864	1.75	4.—
IPROM	82019	1.65	4.—
synthesiser VCO	82027	4.40	10.50
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E81: JANUARY 1982

EPROM programmer	82010	4.65	11.—
synthesiser VCF + VCA	82031	4.25	10.—
frequency multiplier	82041	2.05	5.—

E82: FEBRUARY 1982

synthesiser ADSR	82032	4.20	10.—
synthesiser LFO	82033	3.90	9.50
10 W/70 cm amplifier	82043	2.50	6.—
teletext power supply	82065	1.55	3.50
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darkroom thermostat	82069	2.—	5.—
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E83: MARCH 1982

wind sound generator	82066	1.60	4.—
automatic squelch	82077	1.90	4.50
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E84: APRIL 1982

dynamic RAM card	82017	4.90	11.50
100 W amplifier	82089-1	2.60	6.—
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E85: MAY 1982

6502 housekeeper			
main board	81170-1	4.05	9.50
display board	81170-2	3.05	7.50
elektor artist	82014	10.05	24.—
Z80-A CPU card	82105	7.05	17.—
polyformant:			
debounce unit	82106	2.45	6.—
input unit	82107	4.65	11.—
tune shift	82108	2.75	6.50
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E86: JUNE 1982

the 'Poly bus'	82110	3.35	8.—
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E87/88: SUMMER CIRCUITS 1982

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D/A converter	82112	1.90	4.50
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5 V power supply	82570	2.20	5.—

E89: SEPTEMBER 1982

rugby MSF receiver	80524	5.80	15.—
darkroom computer part I			
keyboard	82141-1	3.75	9.—
keyboard interface	82141-2	2.—	5.—
display	82141-3	2.25	5.50
gas detector	82146	1.60	4.—
house telephone system:			
main board	82147-1	3.—	7.—
power supply	82147-2	1.50	3.50
three phase tester	82577	2.70	6.50
TV games:			
'rapid loader'	82558-1	3.45	8.—
EPROM plug-in board	82558-2	1.95	4.50

E90: OCTOBER 1982

darkroom computer part II			
light meter	82142-1	1.75	4.—
temperature meter	82142-2	1.60	4.—
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active antenna:			
R.F. board	82144-1	1.55	3.50
power supply	82144-2	1.55	3.50
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wave shifter for SSB:			
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E91: NOVEMBER 1982

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floppy disk controller	82159	4.70	11.—
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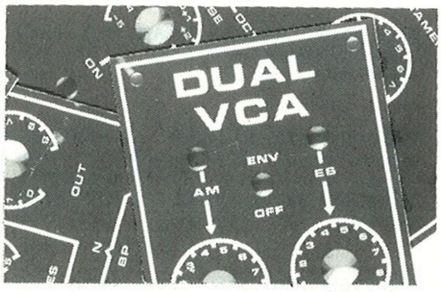

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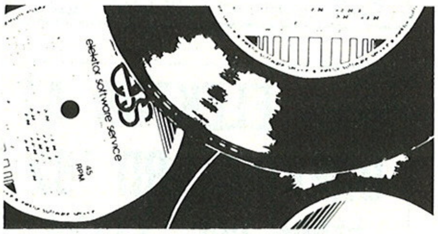

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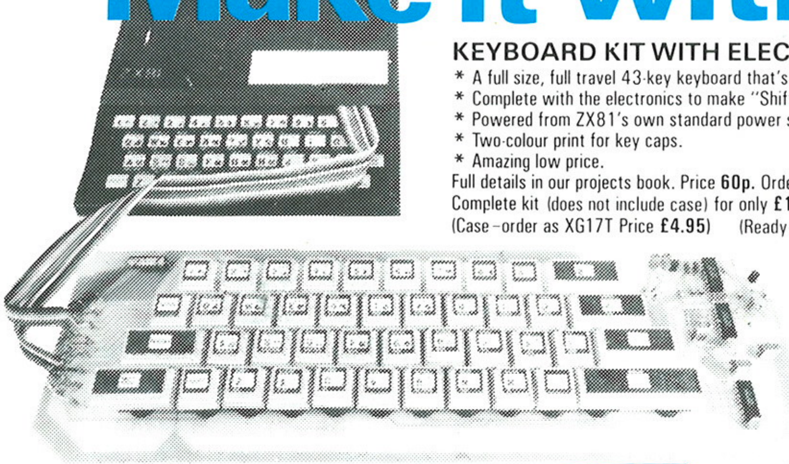

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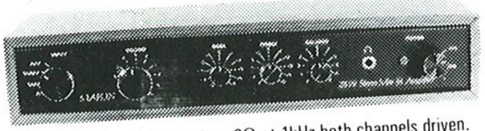

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